The FOUNDRY

Volume 49
Number 22

Published
Semimonthly

CLEVELAND, OHIO, NOVEMBER 15, 1921

Making Water Turbine Castings—I

Molding the Large Scroll-Case Castings Is Described—Skeleton Patterns Keep Down the Expense of Equipment—The Same Molding Method not Suitable for All Casings

BY H. E. DILLER

PROFESSIONS and trades are becoming so broadly inclusive that branches of them are being segregated and specialists are being developed along each branch. In former days it was customary for an apprentice to learn the board general principles of a trade before beginning to specialize, but lately, in many cases, little is learned besides what actually is needed in the particular line in which the novice intends to specialize. Too, some trades are being so interlaced with other trades that the work once considered essentially part of one trade is carried out by another trade or profession. This latter is the case with the molding trade. Molding machines and complicated pattern mounting have developed a line of specialists who are

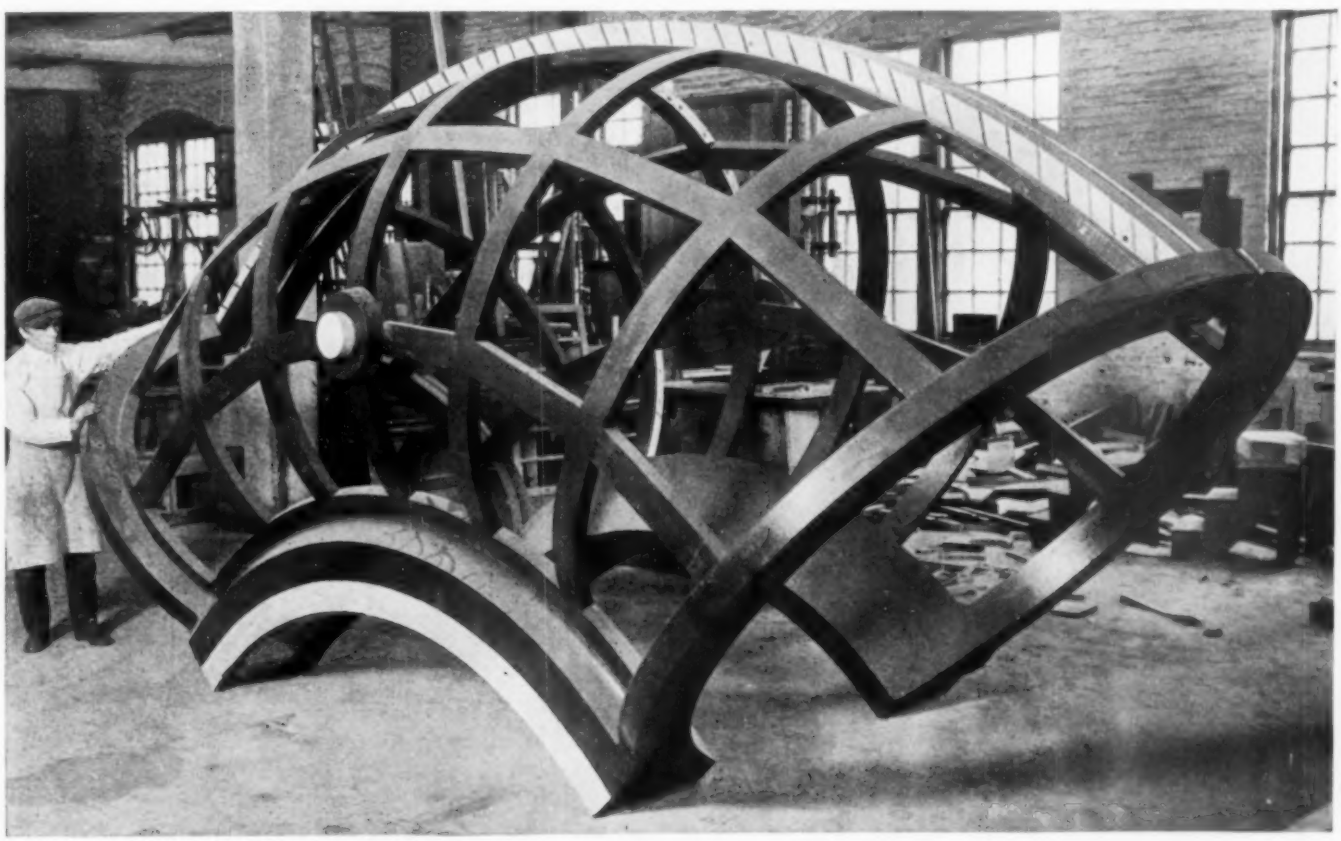


FIG. 1—SKELETON PATTERNS ARE MADE AT A SMALLER COST THAN SOLID PATTERNS—SKETCHES TO SIZE MADE ON A LAYOUT BOARD SERVE TO CHECK EACH PIECE ENTERING INTO THE PATTERN

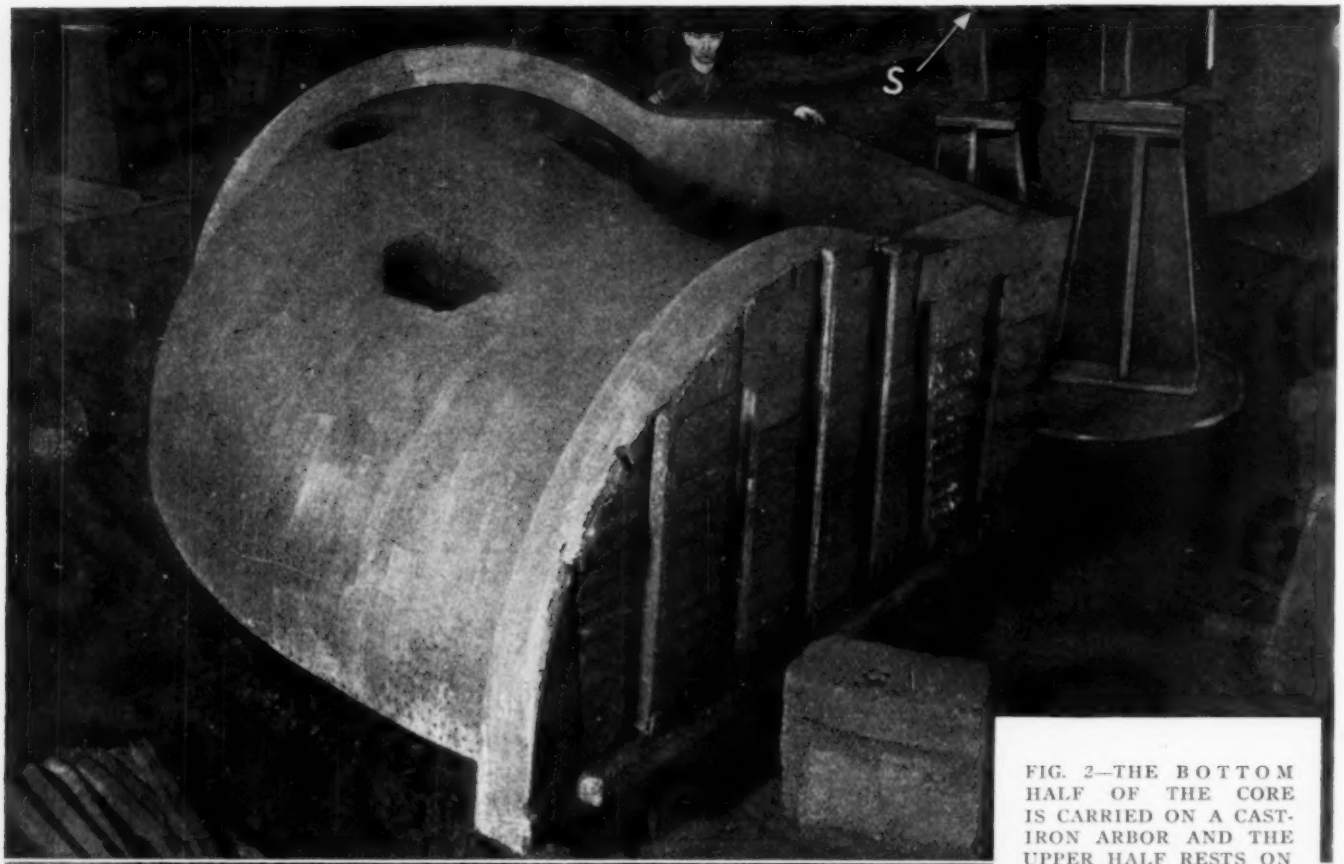


FIG. 2—THE BOTTOM HALF OF THE CORE IS CARRIED ON A CAST-IRON ARBOR AND THE UPPER HALF RESTS ON A PLATE FIG. 3—WHEN THE PATTERN IS DRAWN THE MOLD IS FINISHED BY EXPERT MOLDERS

more nearly related to the machinist's than to the molder's trade. The foundryman must understand the operation of the machines which are on the market, to enable him to make an intelligent selection of those best adapted for the different classes of work which he has in his shop; but the invention and construction of the machine is in the hands of men particularly fitted for that work. After the machine is selected, the foundryman and the patternmaker must decide on the most economical and efficient method for mounting and attaching the patterns; often a difficult point to determine. In fact, so much is dependent upon the selection of the proper machine and the design of the pattern equipment that some foundries employ specialtists to handle this particular problem.

In some cases the equipment merits and receives serious consideration before it goes to the molder, but often the principle has been worked out previously in so many similar cases that little thought is required to adapt it to the particular job. Exercise of skill and judgment on the part of the molder who gets one of these jobs is reduced to a minimum, all he has to do is mechanically to go through certain definitely defined motions. The man who works on such jobs is called a machine molder and devotes practically no time to learning the trade. Of course, a few expert bench molders can be found who thoroughly know the trade of light molding and can produce complicated work without the aid of a machine, but probably a larger number of skilled molders are engaged on heavy floor work. Fewer machines have been invented for application in this class of work and besides, the orders are more frequently for short runs or for single castings. For the heaviest castings, no machines so far have been applied in making the molds. Dependence is placed upon the patternmaker, the foundry foreman and the molders. Therefore, it follows that a foundry doing much heavy work must have a large corps of skilled and highly trained molders. Work of this character taxes the ingenuity of the pattern shop superintendent and the foundry foreman, in planning the way a definite job should be handled and requires study and skill on the part of the molder who executes it.

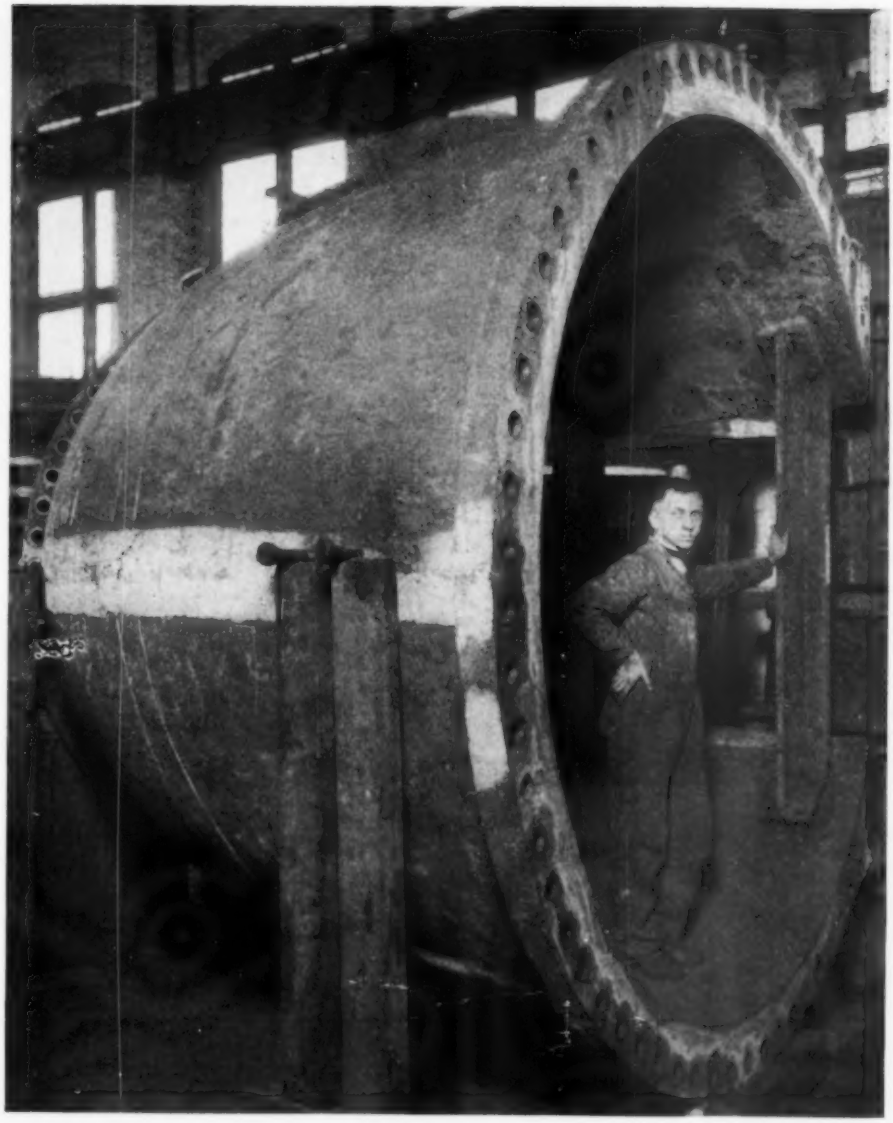


FIG. 5—THE SECOND SECTION OF A 10-FOOT SCROLL CASING IS MUCH HIGHER THAN A MAN—DENSE METAL IS REQUIRED ESPECIALLY IN THE FLANGES WHERE BOLT HOLES ARE DRILLED

FIG. 4—THE COPE IS LIFTED OFF THE MOLD AND AFTER BEING SLICKED AND BLACKENED IS DRIED WITH COKE FIRES

Castings from Skeleton Patterns

A description of the molding methods employed at the foundry of the S. Morgan Smith Co., York, Pa., manufacturer of water turbines, will include examples of big work which are extremely interesting in that they show the results developed after many years operation on the same class of castings. Only a few, or, in some cases, only one casting is ordered of

FIG. 6—IN THE MOLD SHOWN THE CORE IS BUILT VERTICALLY INSTEAD OF HORIZONTALLY AS DESCRIBED FOR THE FIRST CASTING MENTIONED—TWO DRAWBACKS ARE MOLDED ON EACH SIDE OF THE CORE

a particular design. This requires that the casting be made with as little equipment expense as possible. To make a complete pattern for a large and complicated casting is exceedingly expensive and so it is the policy of the Smith company to make many water turbine castings from skeleton patterns. Before describing the molding it will be well to see just what castings are required to make up a complete water turbine. The central cast-

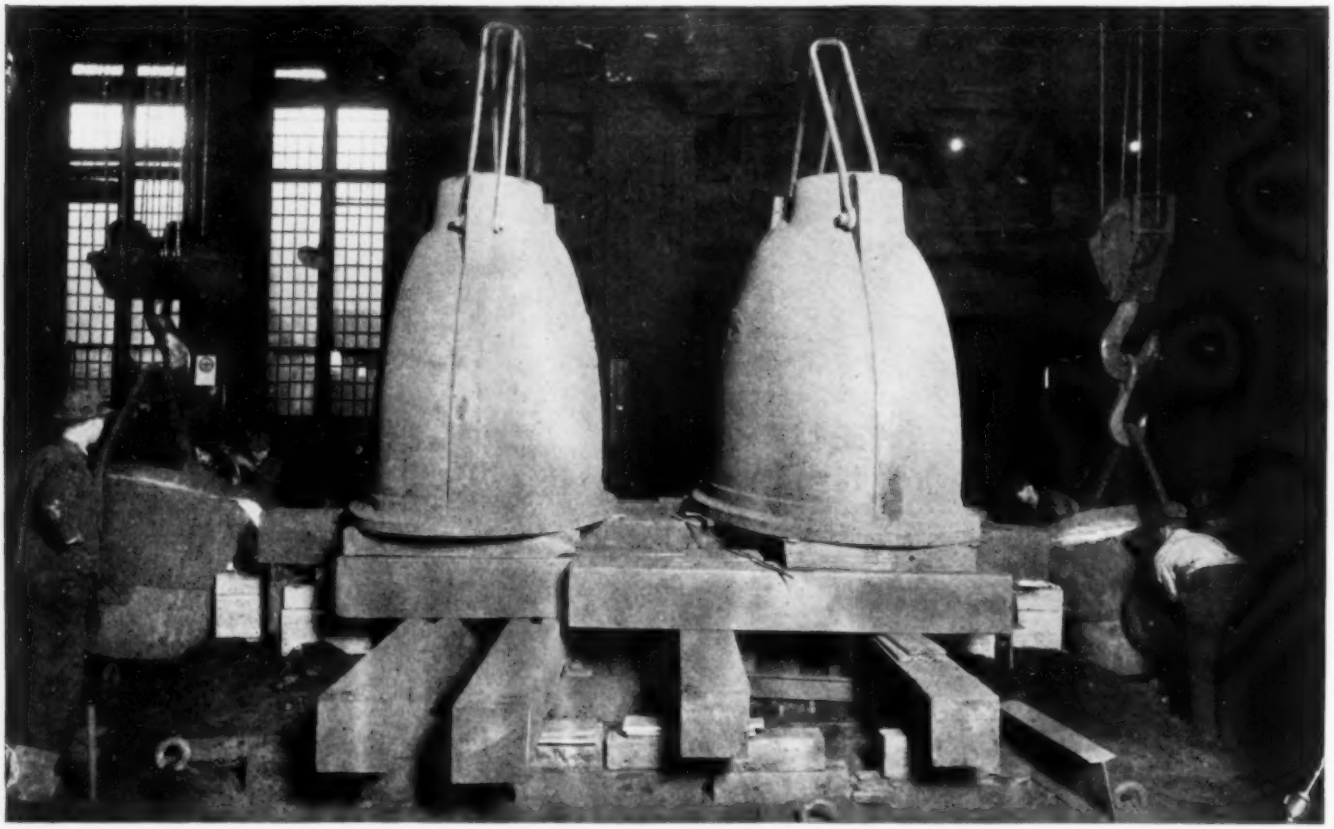


FIG. 7—MOLDS FOR SCROLL CASINGS ARE WEIGHTED DOWN AND POURED FROM EACH END—A HEAVY LAYER OF CHARCOAL IS KEPT OVER THE METAL WHILE THE LADLE IS FILLING

ing is the wheel runner, consisting of a hub and a band into which steel-plate curved vanes are cast. Sometimes the entire runner, including the vanes, is cast of gray iron, bronze or steel. Around the wheel fits a guide-ring casting which is formed of two rings connected by cast-iron vanes. The casting which encircles the guide ring is a large spiral, open along its inner circumference, and called a scroll casing. This usually is made in two or more sections depending upon the size of the turbine. Water enters the inlet of the scroll under a head which sometimes is as high as 800 feet. The inlet opening of the spiral varies greatly, ranging from more than 10 feet to less than 1 foot in diameter. The water passing around the spiral enters the guide ring, which is stationary at all points, gaining access to it from a narrow opening in the inside curve of the spiral. To retain a constant velocity of water in the spiral, it is necessary that the diameter of the spiral decrease as the volume of water flowing through it becomes less, so as the spiral winds around the guide ring, the cross section becomes gradually less. Flowing through the guide ring, the water strikes the vanes of the runner, turning it, and then discharges through the draft tube. The wheel in turning revolves a shaft to which a generator is attached.

Study the Drawings

Besides the runner, the guide ring and the scroll case, a number of other castings, including bases, supports and auxiliary equipment, are required, but the most interesting from a molding standpoint are the first three. The larger spiral castings are made from skeleton patterns, one of which is shown in Fig. 1. When the order is sent to the shop, the head patternmaker and the foundry foreman receive blueprints of the castings to be made, and a consultation is held to determine the best way to make the pattern to facilitate molding. Then the patternmaker foreman gives the drawing to several workmen and tells them what sections each should make. These patternmakers, after studying the drawings, decide how they want to lay out their work and get out the lumber. Several views are laid out to actual size on a layout board, after the board has been planed to remove the marks of the sketch on it from the previous job. Then pieces of wood are glued to make the sections and laid on the board. Sizes are transferred from the layout board to the prepared pieces of lumber by rule, square and trammels and the pieces are sawed out on the band saw. Then the sawed pieces are fitted on the layout board to determine whether their lines correspond exactly to the drawing. In this way every piece entering into the pattern is accurately measured. Meanwhile, the foundry foreman studies the drawings and decides what equipment he needs. Often a lifting plate or two are required and he has the foundry carpenter make a rough pattern and pours the mold in open sand, placing any required rods and lifting loops in it.

A description of the molding of the second section of a 10-foot scroll casing will serve to illustrate the method of molding with the skeleton pattern. These castings are designated as 10-foot because the inlet opening is 10 feet in diameter. The scroll is made in 6 sections and each succeeding section is smaller than the one before it. The second section of a 10-foot scroll weighs approximately 40,000 pounds and has walls 2½ inches in thickness.

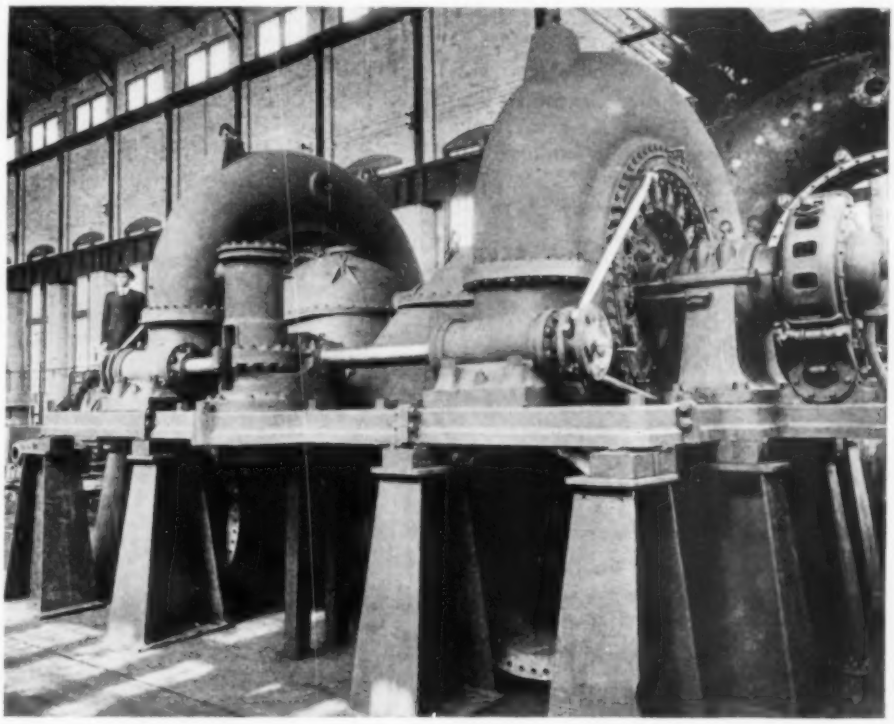


FIG. 8—SMALLER TURBINES HAVE SCROLL CASES WITH LESS PARTS THAN THE 10-FOOT CASE WHICH HAS SIX SECTIONS

Supports for Core Arbor

In commencing to make the mold as shown in Fig. 3, a hole is dug in the foundry floor approximately 18 inches deeper than the lower half of the pattern. Foundation blocks designed to carry the ends of the core arbor are bedded down solidly in their proper relative position at each end. Cinders then are spread over the bottom of the pit to a depth of about 4 inches, after which black sand is rammed until a bed approximating the shape of the bottom of the pattern is formed, at a predetermined distance below the foundry floor line.

Drag Molded

The drag half of the pattern is lowered into place, adjusted in position relative to the blocks for supporting the core arbor and also in regard to the parting line. It is blocked and wedged firmly into place, after which the flanges and ribs are tucked with facing sand. Bottom boards temporarily wedged into place serve to prevent the sand from coming through between the ribs while the outside is being rammed with black sand up to the parting line.

The wedges and blocking are removed piece by piece as the ramming progresses, and after the inside has been cleaned out, a number of strikes conforming to the various diameters are employed to shape the inside of the pattern to the desired shape. This process also includes the forming of a core print at each end about 6 inches in length. Instead of parting sand, newspapers are spread all over the inside surface of the mold, including the core prints, to serve as a parting medium.

On account of the great weight and also on account of the greater convenience in handling the core, it is made in two pieces, split longitudinally along the same center line as the pattern. The bottom half is carried on

a substantial arbor formed of two backbones 6 feet in length, on which loose wings are strung and attached by wedges at 6-inch intervals. The end wings are attached to the backbones by flat steel bars and bolts as shown at *S* Fig. 2. The top half of the core is carried on a heavy cast iron plate conforming to the shape of the castings and provided with 4 lifting loops.

Making the Mold

The arbor for the lower half of the core is clay-washed and lowered into place. Just before the lower edge of the wings touches the face of the mold, it is held suspended on the crane while iron blocks shown at *KK* Fig. 3, are built up to support it. The crane then is disengaged, the mold faced, gaggered and rammed to the top in the usual way. Coke is employed freely in the center, to assist in venting the core and also to facilitate contraction after the casting is poured.

A joint is made at the parting line, after which the lifting plate for the upper half of the core is set on. The upper half of the pattern is then set on and rammed full of sand, with generous supply of coke in the center. In this instance, the sand is rammed flush with the outside of the ribs, with the exception of the two outside ends, where it is made up to correspond to the interior size of the casting. Concave-shaped strikes are employed to sweep the outside of the core to the proper shape, after which the surface is covered with newspapers. The special cope with open ends, shown in Fig. 4, is employed to cover the mold.

When the cope is rammed, it is lifted off, slicked, blackened and then dried by a coke fire placed under the arch, Fig. 4. Sheet iron set up around the ends and sides helps to localize the heat. The sand between the ribs of the pattern on the upper half of the core is cut out an inch inside the pattern. The space is filled with facing sand, vented with a wire down to the coke and then swept to the finished size of the required core. The upper half of the pattern is then removed after which the crane is hooked on to the lifting loops provided for that purpose, and the upper half of the core lifted off and set down in a suitable place, where it is finished and blackened ready for the oven. The lower half of the core is lifted by hooking chains on to the parts of the arbor protruding at the ends. It is set up on suitable stands as shown in the upper right-hand corner, Fig. 2, where it is carefully finished and blackened. Both halves of the core are dried in the oven.

The sand between the ribs in the lower half of the pattern is dug out about an inch below the pattern, after which facing sand is packed in and scraped out by suitable convex sweeps, the thickness of sand removed corresponding to the required thickness of the casting.

To insure rigidity of construction and to prevent the pattern from warping out of shape, a heavy piece of lumber is employed at the joint. The space left by this piece of the frame is filled up by hand, with the aid of a make-up piece as shown in Fig. 3, after the pattern is drawn out of the mold. After the mold is slicked and blackened, it is dried by coke stoves, the top being covered in the meantime with pieces of sheet iron. One of the three smaller cores used to form a flange at the end is shown in Fig. 2.

After the mold is assembled, the pit is rammed up solid, thus preventing any danger of a runout. The casting is poured with two ladles, one at each end, as shown in Fig. 7. A dry sand core is employed to catch the first fall of the metal. The face of the core and mold in the vicinity of the gates also is reinforced with nails. As it requires about 45 minutes to melt the necessary 20 tons of iron to pour this casting, a heavy layer of charcoal is used in the ladles to keep the iron hot.

An Alternative Method

All sections are not molded in the same manner. Fig. 6 shows a mold for a second section of an 8-foot scroll which is partly finished. In this case, the core is rammed in the mold and drawbacks are rammed on each side of it. The reason this core is not made in the manner described is because the curve is greater and if put sideways on an arbor, the convex side would overbalance the other side to such an extent that it would be impossible to keep it in position. Therefore, the core first is rammed on an arbor anchored permanently at each end. The pattern is placed on a bed of cinders covered with black molding sand and boards are placed around it to hold the sand. This is then rammed with sand and the center filled with coke as in the case of the core in the first mold described. After it is completely rammed, the side boards are taken away and the sand is swept to form the pattern. A plate for a drawback is lowered on each side and these drawbacks are rammed with sand, a facing being rammed on each of them. A drawback lifting plate for a second drawback is set on top of each of the first two. Two drawbacks are necessary on each side, on account of their unusual size. Fig. 6 shows, on the right, the lower drawback finished. At the left, the second section in the process of being molded is shown. Here may be noted a number of rods supporting the sheet steel forming the outside casing of the drawback and extending through the sand near the core. These rods are cast from over-iron in a cast-iron mold which is first heated with a wood fire.

Arbor Rests on Studs

As may be conjectured, a large body of sand in the drawback is overhung above the curve of the core. An arbor is employed to support the sand in this section. The arbor is rested on the cast-iron studs *A* and is bolted down with bolts, two of which are indicated at *B*. Two of the lifting loops are shown at *L*. When the drawbacks are lifted out, the space left by the strengthening rib of the pattern is stopped off and the surface is slicked and blackened, after which the section is dried in the oven. The pattern on the core is removed after the sand between the ribs has been cut out and the surface has been covered with facing sand. After slicking the surface and blackening the core, it is dried with coke fires. The core, in this instance, is not taken out of the mold.

A view of the second section of a 10-foot scroll casing is shown in Fig. 5, which gives some idea of its size and shape. It also shows the opening through which the water flows to the guide ring. The turbines all are set up and assembled in the shops of the Smith company before they are sent to the customer. Some of the turbines operate in a horizontal position and some in a vertical position. Fig. 8 shows two connected turbines of the smaller size. The water intakes may be noted underneath the platform.

Moves Toronto Office

The Toronto, Ont., Canada, office of the Independent Pneumatic Tool Co., Chicago, has been removed from 32 Front Street, West, to No. 163 Dufferin Street, Toronto. The Toronto office will remain under direction of William McCrae.

Changes Firm Name

The name of the W. A. Cronenberger Co. has been changed to the Standard Chaplet & Supply Co., Twenty-second street and Prospect avenue, Cleveland. The company makes a specialty of foundry chaplets.

How a British Foundry Specializes

Details of English Methods of Making Piston Castings and Pots for Piston Rings—Molding Machines and Centrifugal Casting Make Quantity Production Possible—Specifications for the Iron

BY H. COLE ESTEP
European Manager, THE FOUNDRY

IN A general way it is still true that specialization is not one of the chief characteristics of the British foundry industry, although in the past few years great strides have been made in the establishment of single-purpose shops. Foundries in which motor car cylinders, sash weights, clock frames, and machine-tool beds are made side by side on the same floor do indeed continue to exist, but they are neither as numerous nor as prominent as they were before the fatal fourth of August, 1914. But the war although it gave a tremendous impetus to the establishment of specialty foundries in the United Kingdom, was not the sole cause of their coming into being. The idea of specialized manufacture as applied to the foundry industry had obtained a considerable foothold in England before the war, and a number of such shops were in operation in 1914 and the years preceding. The manufacture of railroad rail-chairs, which was described in THE FOUNDRY Sept. 15, 1920, is a case of specialization. Specialized foundries catering to the automobile industry were also being developed in Great Britain before the war. Among the most prominent concerns in this field is the British Piston Ring Co. Ltd., Holbrook Lane, Coventry, England, which was established in 1909 by W. A. Oubridge. Mr. Oubridge still remains at the head of this company which operates an unusually completely equipped and thoroughly organized specialty foundry. Taken together with the machine shop and auxiliary departments a highly specialized manufacturing plant is available, which the company operates exclusively for the manufacture of automobile piston rings, piston castings, valve guides, flywheels, and one or two other minor specialties. However, while making a variety of castings the British Piston Ring

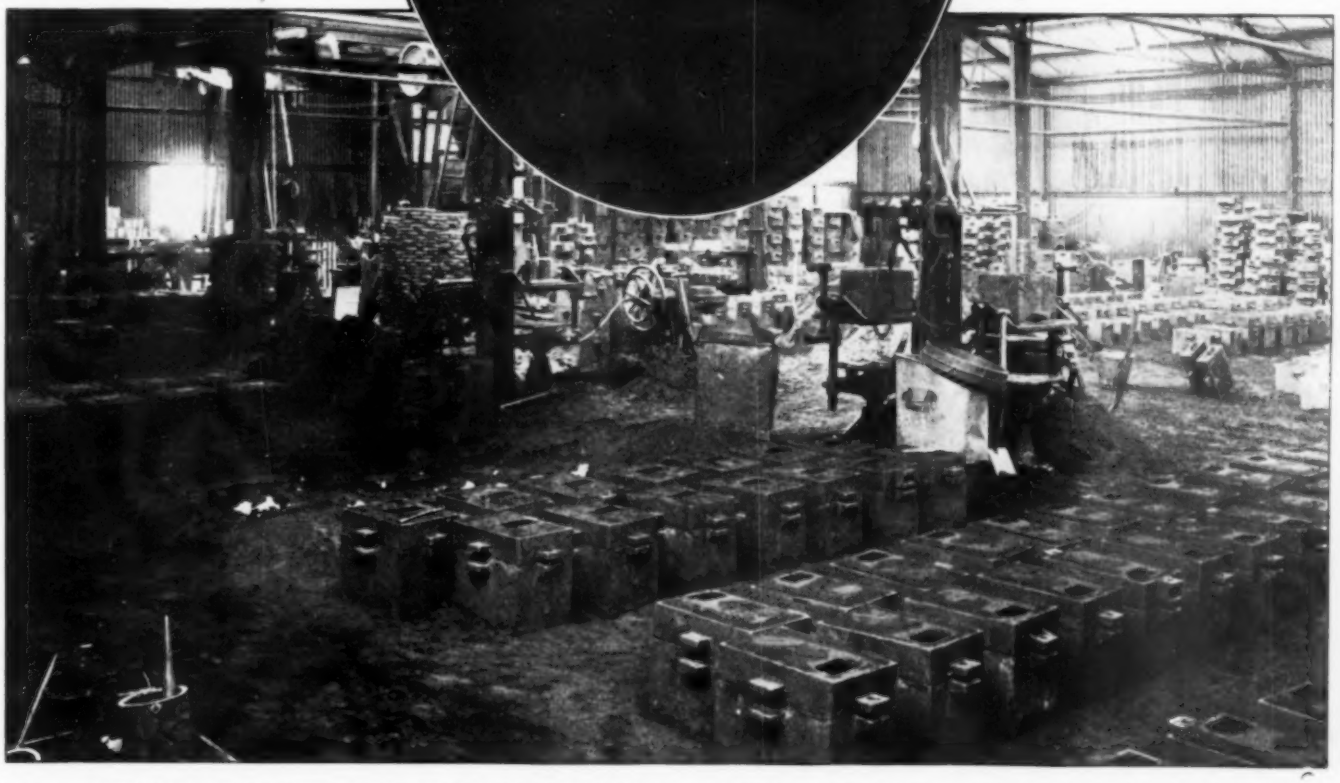


FIG. 1—A BRITISH ADVOCATE OF QUANTITY PRODUCTION AND SPECIALIZATION—W. A. OUBRIDGE, FOUNDER AND HEAD OF THE BRITISH PISTON RING CO. FIG. 2—A GENERAL VIEW OF THE SHOP—ALL THE WORK IS DONE ON MOLDING MACHINES

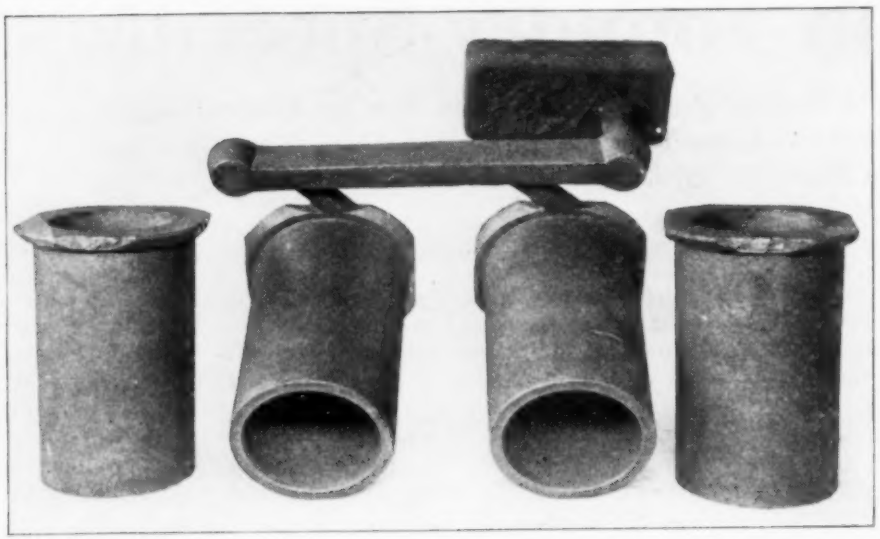


FIG. 3—SAND-CAST PISTON RING POTS SHOWING METHOD OF GATING

Co. concentrates its energies on the production of piston rings and piston castings. In part at least the success of the company under Mr. Oubridge's direction is due to strict adherence to what may be called the American idea of sticking closely to one definite line of manufacture, to the point of exhausting its possibilities, and for this reason a study of the operations of the British Piston Ring Co's. casting plant offers points of especial interest to American foundrymen, and others concerned with high efficiency methods.

The plant has a capacity of 200,000 rings per month. Three acres of land are occupied, and another site is available for future expansion. Railway connections are provided by the London & Northwestern railway through the Foleshill, Coventry, station. There are about 350 employes, of whom 90 are in the foundry. Of the latter not over 10 per cent could be classed as skilled hands, the foundry being operated on the plan of giving semi-skilled men definite training for particular tasks. Owing to methods of control which will be described in detail the foundry scrap is kept down to the low average of 5 per cent, with frequent days when this figure is reduced.

The castings are all gray iron, the metal being melted in cupolas in the ordinary way. The piston-ring castings, however, are made either in sand molds or in permanent molds of the centrifugal type. In either case the rings are produced according to the accepted method of casting a pot, or hollow cylinder, from which an average of 16 individual rings are cut. This method is perhaps more generally followed in Great Britain than in the United States where a greater proportion of individually-cast rings are made. In its sand-molding department, the British Piston Ring Co. is also equipped to make individually-cast rings in special cases where they may be required by British or other customers.

This company has been especially prominent in the development of centrifugal castings in permanent molds. The permanent mold is said to produce a casting with a superior structure and physical characteristics, and is especially suitable for the execution of large orders. The details of the permanent-mold process, using a centrifugal machine, were described by Gwilym Williams, in an article published in THE FOUNDRY, March 15, 1920. Therefore this article will be concerned more with the sand-casting methods, which, as stated, are used not only for the production of rings,

Specifications for British Pistons and Piston Rings

Constituent	Piston castings Per cent	Specification No. 2K6 for sand-cast ring pots Per cent	Specification No. 2K6 for permanent mold cast piston ring pots Per cent
Combined carbon	0.50 to 0.80	0.55 to 0.80	0.45 to 0.80
Total carbon	2.70 to 3.50	Under 3.60	Under 3.90
Silicon	1.20 to 1.80	Under 1.80	1.80 to 2.50
Sulphur, not over	0.12	0.14	0.14
Phosphorus, not over	0.10	1.00	1.20
Manganese	0.60 to 1.20	0.60 to 1.20	0.40 to 1.20

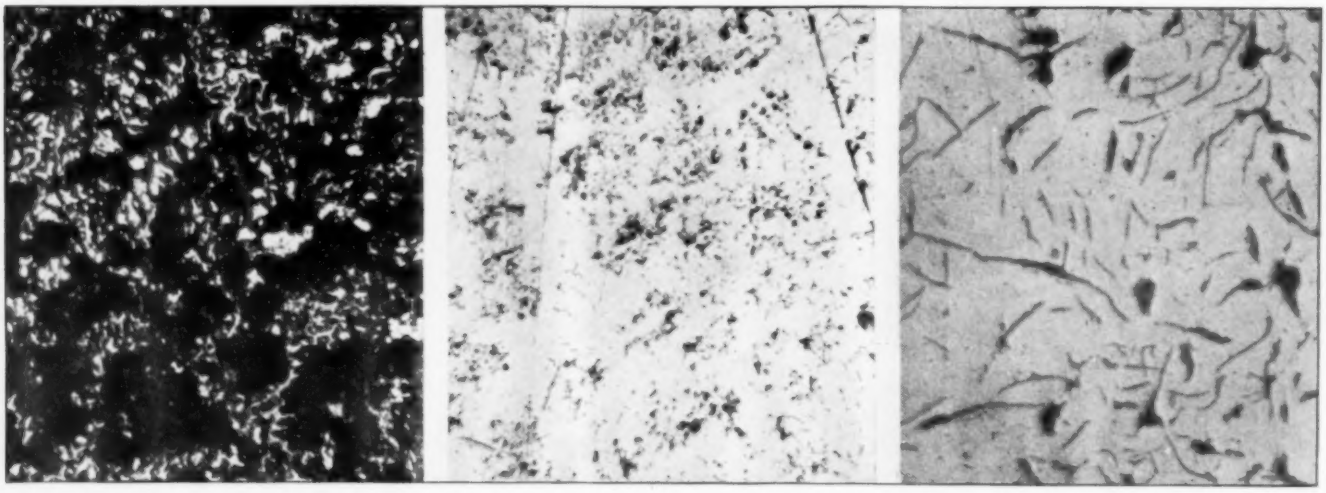
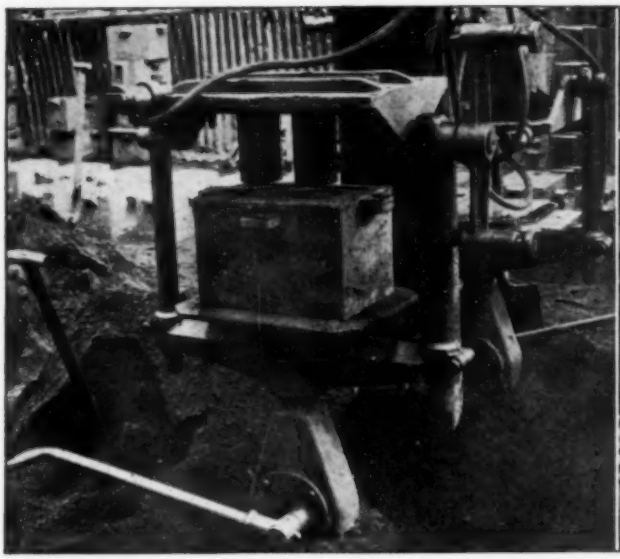


FIG. 4—SAND-CAST PISTON RING IRON FIG. 5—STRUCTURE OF CENTRIFUGALLY-CAST PISTON-RING IRON SHOWING FINE DISTRIBUTION OF GRAPHITE FIG. 6—GRAPHITE PLATES IN ORDINARY GRAY IRON FIGS. 4, 5 AND 6 MAGNIFIED 100 DIAMETERS FIG. 4—ETCHED IN PICRIC ACID



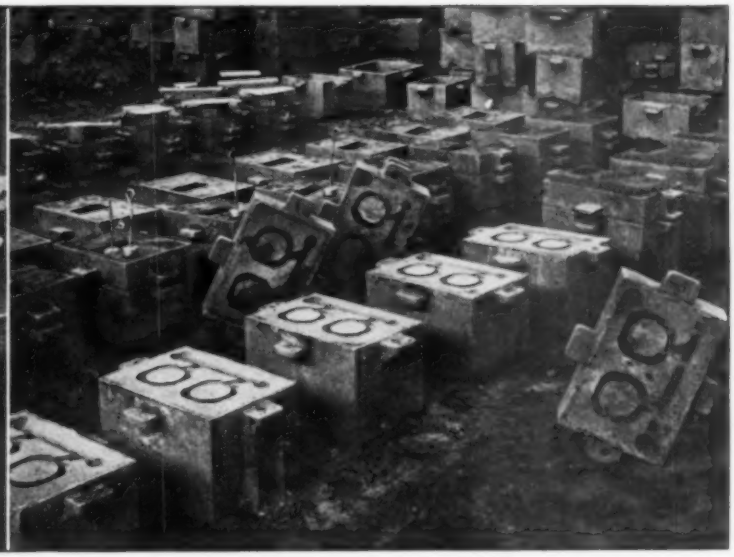


FIG. 7—TURN-OVER PATTERN-DRAWING MACHINE USED FOR MOLDING PISTON-RING POTS FIG. 8—A FLOOR OF PISTON-RING POT MOLDS

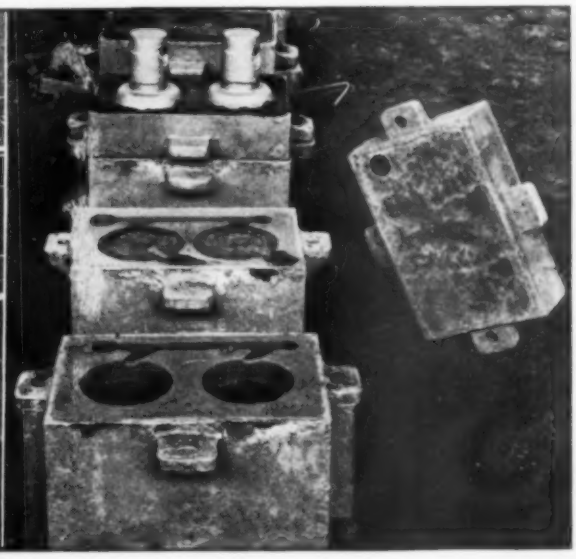


FIG. 9—TURN-OVER MACHINE RIGGED FOR MOLDING PISTONS FIG. 10—DETAIL VIEW OF PISTON MOLDS SHOWING METHOD OF COREING AND GATING

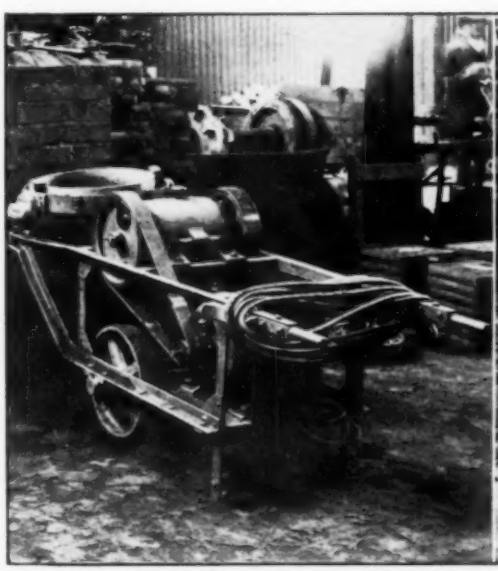


FIG. 11—PORTABLE ELECTRIC-DRIVEN SAND SIFTER FIG. 12—ADAPTABLE MACHINE USED FOR MOLDING FLYWHEELS

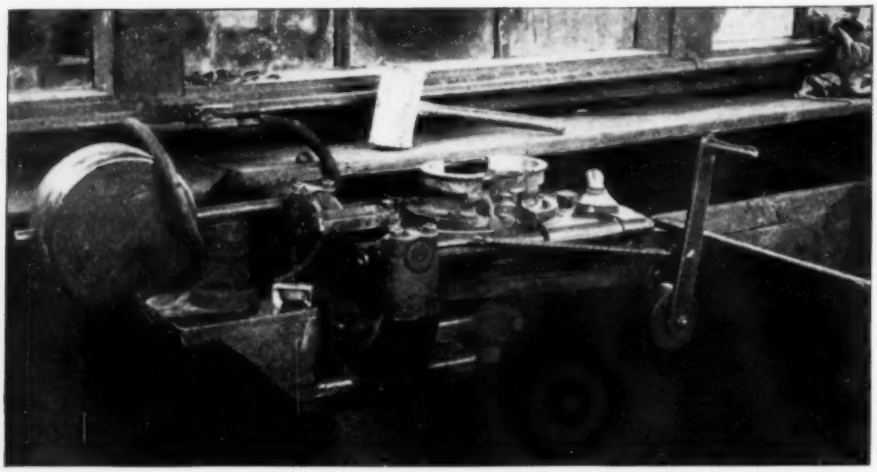


FIG. 13—MACHINE USED FOR MAKING PISTON CORES

but for piston-castings, flywheels, etc. The sand-casting and centrifugal-casting departments are organized and equipped with equal thoroughness, and piston-ring pots are made by either process according to individual circumstances.

Before taking up some of the molding methods in detail it is advisable to be familiar with the requirements which the finished product must fulfill. A piston ring must make a gas-tight seal and have a long life. It must therefore have stregnth to undergo stresses and shocks, resilience to withstand distortion, and moderate hardness to prevent excessive wear. A piston must also possess these same properties although it is permissible for it to be somewhat softer and more machinable. In the case of rings, the proper characteristics are obtained when the iron, although gray, falls just short of being mottled. This necessitates a maximum of combined carbon, short of producing white iron. The essential chemical specifications for pistons, and both sand-cast and centrifugally-cast rings are given in Table I. These specifications were developed by Aircraft Subcommittee W of the British Engineering Standards association and now represent the accepted practice of British motor car engineers. In their compilation the officials of the British Piston Ring Co. took a prominent part.

Differences in Composition

Table I shows clearly how iron suitable for sand-cast rings varies from that required for permanent molds. In the latter case lower combined carbon and higher total carbon is permissible, together with higher silicon. Slightly higher phosphorus and lower manganese also are allowable in the case of metal for centrifugally cast pots. The slight differences in chemical composition between iron for pistons and for rings, as provided by British specifications, also are shown in Table I.

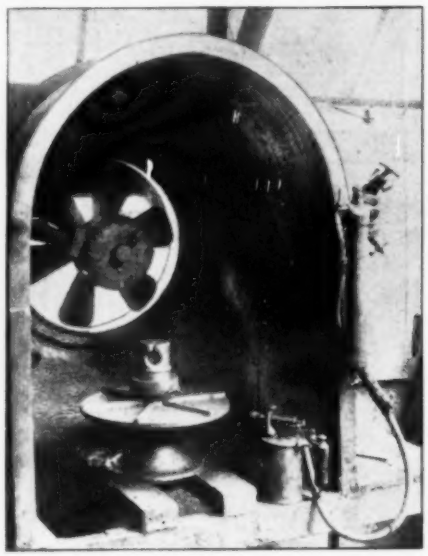


FIG. 14—SPRAYING APPARATUS FOR BLACKING PISTON CORES

Structure and Strength Important

A section of a good piston ring, when viewed under the microscope shows a eutectoid or pearlitic matrix, with the graphite finely distributed, suggestive of the temper carbon of malleable castings. There also is a phosphide network. This structure, compared with ordinary gray iron having large graphite plates, is shown in Figs. 4 and 5, the ordinary gray iron being shown in Fig. 6. These micrographs are all to the same scale, 100 diameters. Figs. 4 and 5 illustrate the differences in the structures of sand-cast and centrifugally-cast piston-ring pots made to the 2K6 specification, Fig. 4 being sand-cast metal, and Fig. 5 centrifugally cast. In both cases, the graphite distribution in the piston ring iron is superior to that in ordinary iron. The paper previously referred to says, "This distribution of graphite materially helps in giving the iron a good tensile strength as well as elasticity."

Piston-ring iron having the characteristics shown in Figs. 4 and 5, is just off the mottled, and is moderately hard in regard both to wear and machineability. In fact the British Piston Ring Co. machines its piston-ring pots, in connection with other tests, at only 45 feet per minute with high-speed steel tools. This shows

FIG. 15—ROLL-OVER MACHINE RIGGED FOR MOLDING LARGE POTS

that the hardness is about right. If the ring were white it would tend to score the cylinder, while if it were very gray it would wear excessively rapidly.

The strength of the metal is determined by physical tests which will be discussed more in detail later. Although no steel is used in the cupola mixtures, some remarkable results are obtained by the British Piston Ring Co. The average tensile strength of the rings or pistons is 17.5 long tons, or 39,200 pounds per square inch. This is gray iron without the addition of any steel scrap in the cupola, and the significance of the figures is emphasized by recalling that during the war the U. S. army specifications for semi-steel shell called for only 32,000 pounds per square inch. Some of the details which help to produce these results will now be described.

All the castings for pistons, rings, flywheels, etc., are machine molded. There is no floor work. A general view of the foundry is shown in Fig. 2. The building is a steel-frame structure with a saw-tooth roof giving ample light to all points in the shop. The two cupolas, which have a combined capacity of five tons per hour, are conveniently placed at one side of the molding room, in such a position that the hot metal may be distributed with a minimum carry. Owing to the light character of the product, crane equipment is unnecessary, and the hot metal is carried by hand in one-man shanks or two-man pouring ladles.

The sand-cast piston-ring pots are molded two or more in a flask on a hand-ramming turn-over pattern-drawing machine shown in Fig. 7. This machine is of a type, modified, built by the Britannia Foundry Co., Coventry. For automobile rings two pots are cast in a flask. Metal patterns, which form their own cores, are used, together with a cast-iron flask as shown. The flask is approximately 15 inches long and 11 inches wide, the drag being 9 inches and the cope 2½ inches in depth. The latter is machine molded on a Farwell squeezer built by the Adams Co., Dubuque, Iowa. The cope is nothing but a cover, the pots being cast entirely in the drag, as shown in Figs. 7 and 8. The gates, which also are very simple, are in the drag, with a short runner through the cope as shown in Fig. 8. The latter is connected to a pouring basin, illustrated in the background in Fig. 8. When the metal is poured access to the runner is cut off by a cast-iron stopper which is removed when the pouring basin is filled. This prevents dirt from getting into the mold. A pair of pot castings as they come from the sand, showing gates, sprues, runner, and the runner-head formed in the pouring basin is shown in Fig. 3. One man working on the machine shown in Fig. 7 puts up 90 molds a day and pours them off himself. He spends about five hours molding and three hours casting. As previously stated an average of 16 piston rings are cut from each pot casting. One molder therefore turns out the equivalent of 2880 rings in a day.

The sand is placed on the floor near the machines and shoveled into the flasks. Mansfield (England) sand is used. The floor sand at each machine is riddled by the portable motor-driven sifter shown in Fig. 11. This machine is made by J. W. Jackman & Co., Manchester. A gyratory riddle built by the Great Western Mfg. Co., Leavenworth, Kans., also is available. Facing sand is used next to the pattern in all the molds in order to obtain a satisfactory finish. The facing is ground with sea coal in a muller shown in the background in Fig. 11. The facing also passes through a rotary disintegrator.

The pistons are molded on turn-over machines similar to those employed for molding the ring pots. A machine fitted with piston patterns is shown in Fig. 9. Metal patterns are used. The pistons are cast two, four or six in a flask, usually four for the

FIG. 16—INTERIOR OF SAND-BLAST CABINET SHOWING ARRANGEMENT FOR CLEANING INSIDE OF PISTON CASTINGS
FIG. 17—SCRAP NOTICE-BOARD ON WALL OF SHOP FIG. 18—DRILL FOR TESTING HARDNESS OF CASTINGS

ordinary sizes. In this case the flask, which is cast iron, is of the same general size and construction as that for the corresponding ring pots. The turn-over pattern-drawing machine is employed instead of a stripping plate machine, because the relatively small quantities specified by British customers do not warrant the extra expense of the stripping-plate rigging, although its advantages from the molding standpoint *per se* are recognized.

Core Making Is Efficient

A special machine, Fig. 13, desinged by W. A. Oubridge, built by the Adaptable Moulding Machine Co., Birmingham, is employed for making the piston cores. This machine carries a split core-box, the two halves of which slide on steel guide rods. After the core is rammed-up, it is turned over, and by means of the lever the box is opened, leaving the finished core, as shown, on the receiving stand at the left. The turnover gear is counterweighted.

Instead of the oil-sand cores consisting of pure silica sand and oil which are almost universally used in the United States for work of this character, a rather elaborate core-sand mixture is employed. The essential ingredients are old cores, black sand from the floor, new sand, horse manure and core gum. The mixture consists of a barrow of black sand, with which any ground-up old cores that may be used are incorporated, together with three-quarters of a barrow of new sand and a riddle full of manure. The core gum is added to the proper consistency for binder. The core machine is worked by a boy who makes about 150 cores in an 8-hour day.

The ingenious arrangement shown in Fig. 14 is employed for blacking the cores. The core is set on a small turntable, as shown, and sprayed with a sprayer manufactured by the De-Vilbiss company, Toledo, Ohio. A sheet-iron hood protects the operator and the fumes from the spraying are drawn out by the exhaust fan at the back. After the cores are blacked, they are dried in coke-fired ovens located across the gangway at one end of the core room.

Large piston rings for steam engines also are made. They are made

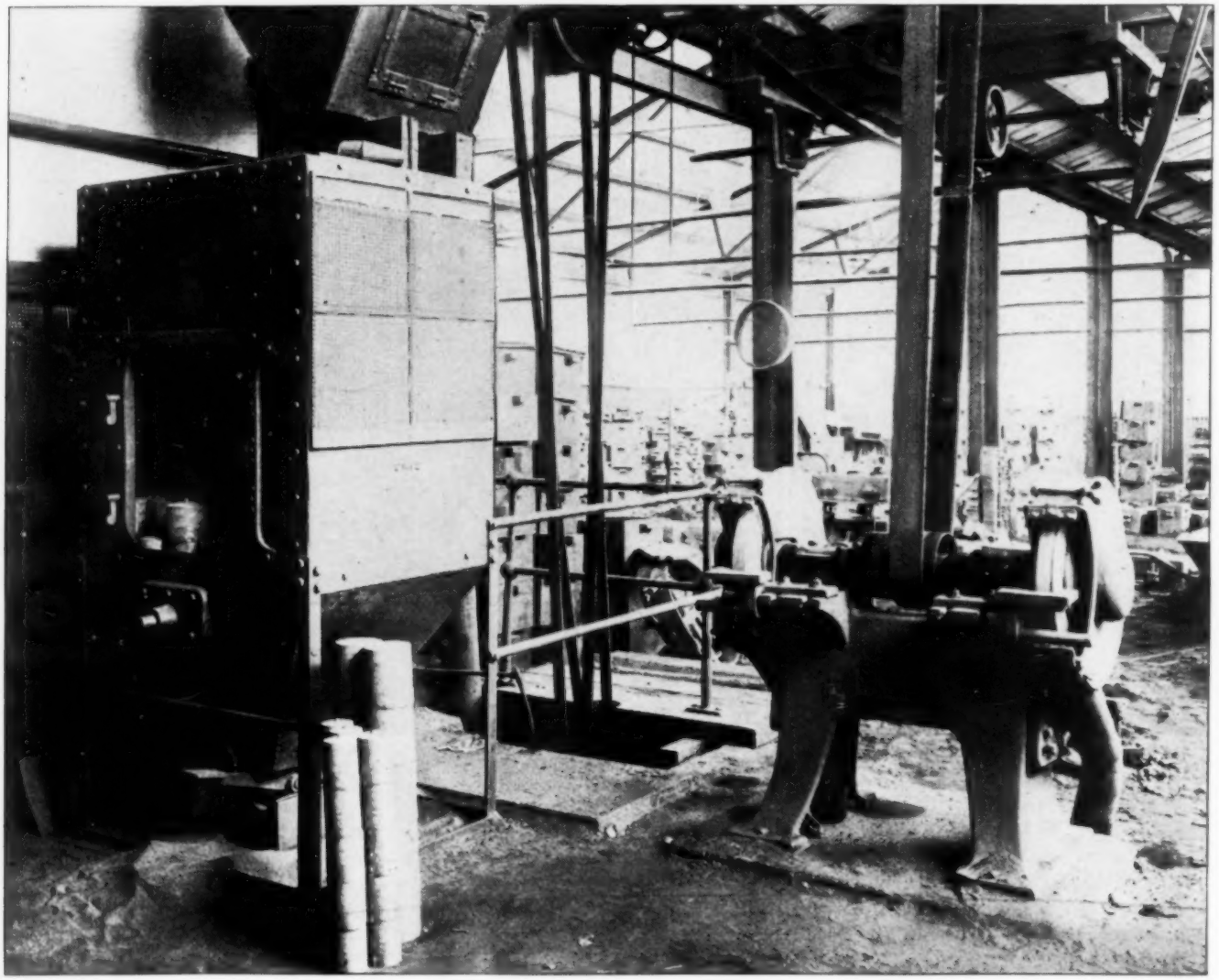


FIG. 19—A CORNER IN THE CLEANING DEPARTMENT SHOWING LOW-PRESSURE SAND-BLAST MACHINE AND GRINDING WHEELS

The production is about the same as in the case of ring pots. It should be pointed out that all the man at the machine does is to set the molds on the floor. The setting of cores, closing, etc., is done by other men who are more highly skilled. The machine hands and coremakers are only semiskilled, and as previously mentioned, the skilled men constitute only 10 per cent of the force.

The piston casting is all in the drag and the gating is the same as for the ring pots. Dry-sand cores

FIG. 20—TEMPERING OVEN FOR TREATING CENTRIFUGAL CASTINGS

from pot castings the same as the smaller automobile rings. For making the molds a hand-rammed roll-over machine built by the Grimes Molding Machine Co., Detroit, is provided. This operation is shown in Fig. 15. The process is virtually the same as for the smaller pots, except that there is only one in a flask.

Flywheels for automobile engines also are made in considerable quantities in the sand-casting department. They are molded one in a flask usually from metal patterns, using the Adaptable machine shown in Fig. 12. The flywheels are cast with a large runner in one corner of the flask and a riser in the center. As soon as the mold is poured the metal in the runner is squeezed by the workman, using the back of a shovel protected from the hot metal by a little sand. He continues to exert pressure on the runner until the riser ceases to bulge up. This is said to be more effective than feeding in the ordinary way.

For squeezer work, machines built by the Adams Co., Dubuque, Iowa, are installed.

The castings are cleaned by sand-blasting, using a Jackman low-pressure sand-blasting machine working on 15 pounds of air. The nozzle points up and the piston castings are placed on a stool in the machine to clean their under sides. This arrangement is illustrated in Fig. 16.

The melting equipment consists of two cupolas. One, which is 36 inches in diameter inside of the lining, was furnished by the Whiting Corp. Harvey, Ill. The other, 24 inches in diameter, was built by Alldays & Onions, Birmingham, England. The

FIG. 21—A 20-INCH DIAMETER RING CAST CENTRIFUGALLY

Whiting cupola is operated at the rate of three tons an hour, and the smaller one at two tons per hour. The cupolas are operated under the strictest laboratory control. A completely equipped laboratory both for routine and research work is provided on the premises.

Chemical requirements are given in the table, page 880. Silicon varies from 1.20 to 1.80 per cent, but when working on certain sizes of rings must be kept uniform within one point. No outside scrap is employed, the cupola charges consisting exclusively of returned foundry scrap and pig iron. Considerable home scrap is available, since as in the case of pots and pistons, 40 per cent of the weight of metal poured goes into sprues and gates. In the case of flywheels the proportion of sprues is 20 per cent. The mixtures vary according to pig-iron market circumstances, and the sizes of pots or pistons being cast. For the smaller sizes it is not considered advisable to use over 25 per cent scrap, while for the larger pistons scrap up to 75 per cent may be melted. But foundry pig irons, with a sprinkling of hematite, or low-phosphorus, irons make up the backbone of the charges.

Volume Gage is Employed

The cupolas are connected to a motor-driven fan blower which discharges the air through a 10-inch pipe. A blast-pressure gage of the usual type is employed, together with a volume meter manufactured by Chas. J. Clark Blast Meter Co., Gladbrook, Iowa. The bedcharge of coke is 30 inches deep in the large cupola and 24 inches in the smaller one. The height of the bed is gaged by a rod reaching

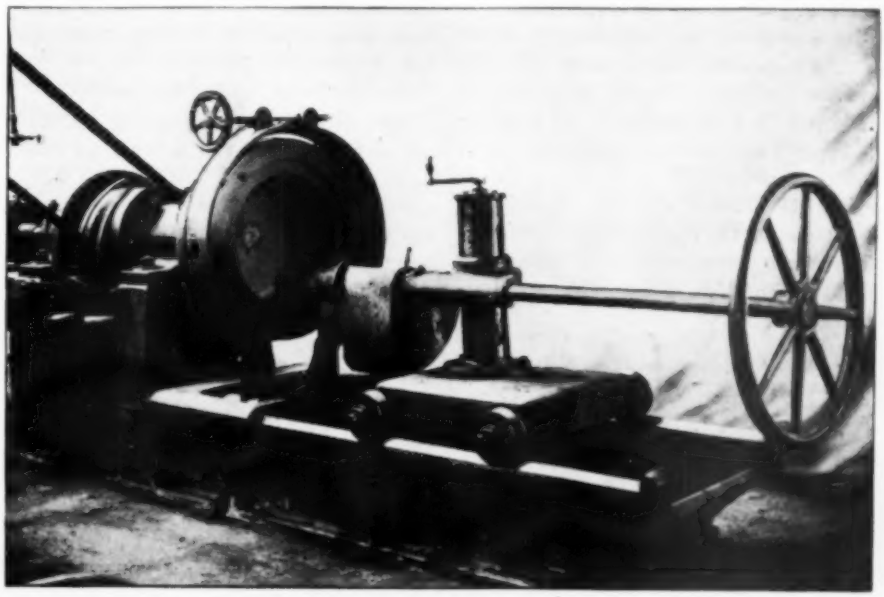


FIG. 22—MACHINE FOR MAKING LARGE CENTRIFUGAL CASTINGS IN PERMANENT MOLDS

up to the charging door. A 10 to 1 melting ratio, exclusive of the bed charge, is obtained. The charges for the Whiting cupola consist of 56 pounds of coke to 560 pounds of iron; for the smaller cupola the charges are 28 pounds of coke to 280 pounds of iron.

The melting operations are carefully conducted to obtain metal of the proper composition and to avoid scrap castings. Efforts to keep down the production of scrap are made all along the line. The molding-machine hands are paid on a piecework basis, with a bonus for output. They are checked, however, by the mold finishers—skilled men—who are paid a day rate and a bonus according the scrap produced. If a mold looks defective when it comes off the machine, these men call the foreman's attention to it. In this way the scrap is kept down to an average of 5 per cent, with not infrequent records as low as 3½ per cent, as shown in Fig. 17. This illustration shows the board on which the scrap for the previous week is posted in a prominent position. This has a favorable psychological effect.

Elaborate Tests and Inspection

The task of controlling the quality of the product is by no means confined to watching the foundry scrap. Every finished casting is examined in the inspection department before it is passed for machining. Scabs and round edges, the former indicating dirt and the latter blowholes, are among the points looked for. The broken gate fractures also are examined, and of course the chemical tests show the composition of the metal. If either indicates white metal every casting in that particular heat is then drill tested. The drilling apparatus shown in Fig. 18 is employed for this purpose. It will be noted that the drill is fed by a counterweight giving a predetermined pressure at the point of contact with the casting. If, under these conditions, the casting can be drilled it is passed; if not it is scrapped.

Ten per cent of the pistons and pots in each cast are machined in a lathe at 45 feet per minute, using a high-speed steel tool, as previouly mentioned. If the castings selected do not machine properly and are too hard, then every casting, that is the remaining 90 per cent, is machined and the bad ones are rejected.

To further control the testing and trace any defects, even after a lapse of years, each piston casting is marked with a heat number on the inside at a point which will not be finished. This number is made up according to a formula which gives the date the casting was poured.

The strength of the metal is determined by testing the casting itself instead of using a test bar. This is done by testing an actual ring in a special machine, or in the case of a piston, by testing a ring cut from the piston. The machine used for this purpose is shown in Fig. 23. The method of testing is described in a memorandum submitted to the Aircraft Subcommittee W by W. A. Oubridge. The machine is properly fitted with knifed edges to grip the ring, and is also provided with means of measuring the extension of the knife edges and calculating the strength of the iron from the scale-beam reading at which the ring breaks. The weight is traversed on the beam by a small motor. The formula for tensile strength is

$$f = \frac{Pd}{1200\ bt^2}$$ in which,

P is the load at which the ring breaks, in pounds.
d is the original diameter of the ring in inches.
b is the breadth or width of ring in inches at point of breakage.
t is radial thickness of ring in inches at point of breakage.
f is the tensile strength of the iron in tons per square inch.

The calculations are based on tons of 2240 pouuds each. The formula could be adapted to the American practice of figuring in pounds per square inch by altering the constant, 1200.

In practice ring blanks are cut from the casting to an approximately square section, and after having a saw cut inserted they are marked axially with a center square for correct position on the knife edges. The original diameter, d in the formula, in taken as the outside diameter of the ring blank, and *b* and *t* at the point opposite the saw cut. The formula was derived mathematically, and the coefficient was determined by testing ring blanks against straight bars. The same machine may be used for testing for permanent set. The high tensile strength, over 39,000 pounds per square inch, which is obtained as a result of these tests has already been commented upon.

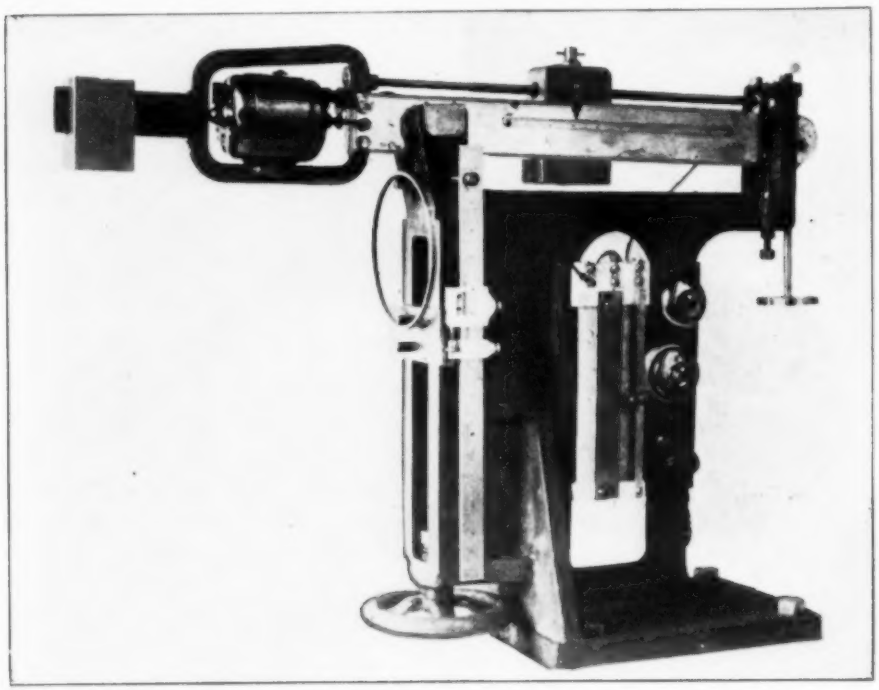


FIG. 23—SPECIAL MACHINE FOR TESTING TENSILE STRENGTH OF RINGS

Large Centrifugal Castings

The centrifugal casting shop is located alongside the gray iron foundry. It is now equipped with four casting machines, one of which, recently developed, is adapted to casting rings up to 20 inches in diameter, weighing up to 275 pounds. This machine is shown in Fig. 20. These machines have already been described in the paper previously referred to.

Later experiments, however, have indicated that the cold method of working is perhaps preferable to working the molds as hot as possible, as earlier experience had seemed to indicate. There are still two opinions on this subject, but the cold working tends to save the mold. The life of the mold is now from 300 to 500 castings, which brings the cost per casting down to a low figure.

A good deal in the success of the process depends on the tempering which the castings receive after they come from the machine. The furnace employed for this purpose is shown in Fig. 22. It is coke fired and maintained at a moderate heat. The red hot rings go in at the left hand end and are pushed through and out into the cooling chamber shown at the right where they cool slowly.

The tempering leaves a definite amount of combined carbon in the casting.

The control of combined carbon is of course important. The silicon necessary to produce a given quantity of combined carbon is considerably higher than in the case of sand castings. This is brought out in the table. It is the high silicon and rapid cooling, resulting in small graphite particles in a eutectoid matrix, which bring about the desirable characteristics possessed by castings made centrifugally in permanent molds.

The melting equipment in the centrifugal casting department of the British Piston Ring Co. consists of a small cupola, mounted on trunnions, of the type built by the Constructional Engineering Co., Birmingham, England, together with a pot furnace which really serves as a reservoir for metal which has been melted and is waiting to be poured.

The British Piston Ring Co. started operations in 1909 and its success has been continuous. The present plant was built in 1914. The company is incorporated and capitalized for £50,000. W. A. Oubridge is chairman and managing director. The directors include Cecil Hill and W. N. Lindley. E. B. Pilley is secretary.

The machine shop is well equipped with tools for finishing piston rings, and other work. These tools include a large number of American and British made automatic screw machines and grinding machines. Largely as a result of the inventive activities of Mr. Oubridge and his associates, a number of special machines have been designed and constructed, including special grinding devices, ring hammering machines, etc.

Prophesies Electric Smelting Iron Ores

BY FRANK HODSON

A STATEMENT was made at a recent meeting of the officers of the American Mining congress in Washington by Charles W. Potts, mine operator, of Bearwood, Minn., that present known reserves of high grade iron ore, based upon constantly expanding requirements of the steel industry, will be exhausted in twenty years, and the merchantable grades of iron from the great mines of Minnesota, at the present rate of depletion, will be exhausted within the next fifteen years unless new discoveries are made.

The tremendous significance of this rapid depletion of native high grade iron ore has not been fully realized, but consideration of the amount of the capital invested in iron and steel and kindred industries, and its importance nationally, will indicate the gravity of the situation. If, as Mr. Potts states, our available high grade iron ore will be depleted in twenty years, is there also not a grave danger of our position today in the world's markets passing, unless the vast deposits of iron sands and low grade ores in this country are properly exploited. Other countries—China, Japan, Brazil, India—with cheap labor, have immense deposits of iron ore. They have water power available and already are installing large smelting furnaces operated electrically for reducing the iron ores.

The electric smelting furnaces—using cheap water generated power—will probably in the next few years open up a vast supply of iron ore at present considered almost worthless. Immense deposits of iron sands and low grade ores occur in the Adirondacks, on the Pacific coast, and in many other parts of the country. These ores are at present useless, as they cannot be economically treated in the ordinary standard blast furnace. Most of these deposits are in places where power is, or could be, generated cheaply if the ore would be concentrated and smelted into iron by specially designed electric furnaces.

Must Have Practical Experience

The one thing essential after the financial backing is secured is the selection of the right type of equipment for the work. Many previous attempts to electrically smelt these ores have failed, owing to wrong or no proper technical advice. In a recent issue by THE FOUNDRY it is stated there are no less than 70 so-called *direct* processes for making steel from the ore. Some of these are feasible under certain conditions, but they should not be attempted except on advice from disinterested metallurgists who have had practical smelting experience. If the process is electrical the metallurgist should also have had experience with electric smelting. These *direct* and *secret* processes to give steel direct from ore are the snag that sunk many promising ventures.

Several processes have been developed for smelting iron electrically. Among the most important of these is the Swedish electrometall process. Already 27 large installations, with a total capacity of 100,000 kilowatts are being operated or are under construction in various parts of the world. This type of electric smelter uses the gases generated in the melting zone to preheat and partially reduce the charge. It is not attempted to make steel direct by this process, but in several cases the product is being tapped out into metal mixers or open-hearth furnaces and from there into finishing furnaces. Dr. Stanfield in his report on the commercial feasibility of electric smelting of iron ores in British Columbia, writes:

"In Sweden the electrometal type of electric smelting furnace has proved satisfactory for the production of low silicon pig iron. This is, as far as I am aware, the only type of electric furnace that has ever attained commercial success in the production of pig iron from ores. If a permanent smelting plant were being erected, the Swedish type of furnace would be selected."

Considerable publicity has been given recently to what was termed a recent Japanese discovery that iron sand and low grade ores could be smelted and made into steel. There is absolutely nothing new in this so-called Japanese invention. As long ago as 1907 John T. Jones, Iron Mountain, Mich., had devised a similar process for treating low grade ores. H. A. Greaves and H. Etchells, English scientists and inventors of the successful Greaves-Etchells electric steel furnace, also brought out a process, a few years ago, in which black iron sand is passed down a rotating tube or kiln and from there to a finishing electric furnace. The ore in this tube is preheated and partially reduced by the gases given off in the electric furnace. Finished steel from sand has repeatedly been made by their process. A French inventor, Monsieur Basset, uses a similar method, but in his case external or additional heat is applied to the ore proceeding through the preliminary tube.

As long as good high grade ore is available and coke prices are reasonable electric processes of ore reduction as now developed cannot hope to compete with the standard blast furnace in anything but charcoal iron, or iron of special analysis. With the

falling off in available supplies of high grade ore and the generation of cheap electric power from water power, the electric smelters will come into their own. They can undoubtedly make iron superior in quality to that made in the standard blast furnaces. Very thorough tests made in Sweden and England with this electrically made pig iron also proved that by its use in the open-hearth furnaces considerable time could be saved in the steel making operations. Actual figures have not been published, but in a number of cases that came directly under the writer's notice, the saving in time per heat of steel was between 1½ and 3½ hours. Therefore, although the initial cost of electric pig iron may still be somewhat higher than ordinary blast furnace pig iron, yet considerations such as that mentioned above and the extreme purity of the electric iron do not make the difference in first cost as large as would at first appear.

The electric smelter can also economically handle a large proportion of turnings, borings and cheap scrap in its charge; material that is not suitable except in small proportions in the standard blast furnace.

In sections like the Pacific coast, where good ore is available near cheap, water-generated electric power and where at present most of the coke, pig iron or steel is subject to heavy freight charges, there is a splendid opening for someone with vision ahead to start electric smelters and steel plants.

Probably the future method of making even cheap steels will be to take a hot-blast furnace metal, either from electric or standard blast furnaces, and pour it directly into a large metal mixer where additions of ore, cheap borings and turnings could be made, then transfer this metal to a bessemer converter, where the metal would be given a partial blow only and the deoxidizing and finishing off would be done quickly in a series of electric furnaces.

In the process outlined there would be practically no loss of heat in the whole operation. The addition of ore and cheap scrap in the form of borings, etc., in the mixer would cause a thermic reaction and generation of heat; the bessemer operation would add more heat and all that would have to be done in the electric furnace would be to deoxidize, adjust temperature and, where necessary, refine or make additions of alloys.

Welding Outfit Finds Many Applications

THE welding department is now as much a matter of course in the modern foundry as the pattern shop or the finishing room. The blowpipe is the accepted tool for cutting off steel riders because of its economy and speed. In all welding operations such as filling in blow holes and building up defective portions it is a means of effecting considerable saving. When properly carried out the oxyacetylene weld is free from hard spots, pin holes and contributes to ease and finish in machining.

Repairing broken castings while not so important in the foundry as elsewhere, because patterns usually are available for making new castings and because the material costs are not so high as in a piece of finished machinery, is nevertheless quite common wherever castings can be welded more cheaply than they can be replaced. This is frequently the case and has led to provision being made in many foundries for preheating whenever the welding is to be done in places where the application of a welding heat will set up stresses and strains in the casting.

The foundry lends itself admirably to welding work. As a rule ovens are available for the initial preheating; brick and coke are present for the building of ovens to provide final heating and annealing; and men who are experienced and accustomed to note expansion and contraction of metals always are present to supervise.

In many foundries special spaces are set apart for the welding and cutting operations. An ideal procedure, where ample floor space is available, is to remove the castings from the molds, take them to a regular place for rough cleaning, then to a separate place for cutting off the risers, and finally to the grinders for finishing and after which the defective castings are sorted out for removal to the welding room. An orderly and simple mode of handling the castings is to use storage battery trucks or cranes and monorail hoists carrying separate frames for the loads. In this way the frames may be loaded where the work is done, special work being kept by itself and the loaded frames picked up and deposited in the spaces assigned for succeeding operations.

Acetylene may be supplied either by generator or cylinder, and oxygen may be taken from individual cylinders or from a pipe line fed from a manifold. In building new foundries it is advisable to use welded pipes for the distribution of gases, and to install welded air pipes and welded sand-blast machines. Large diameter pipe used with either low pressure exhaust or supply fans should be welded to prevent leaks which cause daily waste in the additional power required for the make up of the fans. An extra half-horsepower saved soon pays for the entire system. Welded pipe, it is claimed, is both cheaper and better than pipe that is rivetted.

The many ways in which the oxyacetylene apparatus may be applied in the foundry illustrate the flexibility and adaptability of the process. In addition to the uses already mentioned it may be employed for scaling castings, cleaning ladles, burning salamanders, welding pipe, tools, structural shapes, machinery guards, etc.

For scaling castings, a welding flame is applied to the silica scale. This refractory scale has a different expansion from that of the metal upon which it is superimposed and cracks readily under the application of heat. It then may be removed readily. This application does away with hammering. It is a time saver and also makes for easier labor conditions in the foundry.

Oxygen is used successfully in clearing refuse metal and slag from electric and gas furnaces. It is much better than using sledge hammers and bars in cleaning up, is easily and cheaply applied and contributes to the general scheme of neatness and tidiness which is the aim of competent foundry executives.

When any steel work is bent out of true it can be bent back into form by playing a large welding flame over the metal and using a sledge hammer after a red heat has been attained. This process may be applied both to structural and sheet steel.

Worn out or broken steel parts may be repaired by welding. Excellent pipe joints can be made and in fact it is claimed they should always be welded where vibration is pronounced or excessive. Machinery guards, safety rails, etc., are being made constantly by the welding process. The value of a welding outfit

for tinkering around any plant having a machinist is such that a separate portable outfit should be kept for the use of the repair or emergency gang. The man who may be assigned to this kind of work should be provided with literature on welding and cutting. The welder also should make it a point to read the current numbers of the various technical magazines to keep his foundry abreast of the times on developments in welding practice.

Many foundries assign production welders to do odd jobs. This is a mistake and almost always results in retarding production. It is much better to have a regular shop mastermechanic or millwright to look after the odd job in the shop. For most of the work which requires expert manipulation, competent men usually are available.

Finally it should be borne in mind that while repairs to castings even those of moderate size, occupy considerable time and floor space, they are in a great many instances, sources of saving that more than justify the practice.

Book Review

A. S. T. M. Tentative Standards, 1921, 518 pages, 6 x 9, published and sold by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, $5 in paper and $6 in cloth binding.

This volume contains 127 tentative standards including 12 relating to steel, wrought iron and cast iron; 10 relating to nonferrous metals and alloys; and 2 relating to coal and coke. The tentative standards for castings are specifications for electric cast steel anchor chains, and for cast-iron car wheels. Those for nonferrous alloys are specifications for nonferrous alloys for railway equipment in ingots, castings and finished car and tender bearings; white metal bearing alloys; aluminum ingots for remelting and for rerolling; aluminum sheet; aluminum for use in the manufacture of iron and steel; pig lead; brass ingot metal, graded and ungraded for sand castings; and nickel. Also included are tentative methods of chemical analysis of aluminum and light aluminum alloys; and methods of chemical analysis of nickel. Tentative methods of test for fusibility of coal ash, and tentative definitions of terms relating to coke are given.

The term *tentative standard* as distinguished from *standard* is applied to a proposed standard which is printed for one or more years with a view of inviting criticism, of which the committee concerned takes consideration before recommending final action toward the adoption as standard of such tentative standards by the formal action of the Society.

Causes for Blow Holes

Question: We should like to learn if there is a self hardening paste which can be used on small cores without the necessity of redrying the cores. Also it must be of such a character that it will not create blow holes in the casting. We are making aluminum castings 2½ inches in diameter by 5 inches long and 5/64 inch thick. Our metal is poured at a temperature of 1500 degrees Fahr.

Answer: We do not know of any self hardening paste, that is a paste that will dry perfectly without the application of heat. However there is no reason why you cannot paste the cores while one half is green. In that way one drying will dry the core and the paste. Several substances on the market prominent among them being flour and dextrine are used extensively for pasting small as well as large cores.

The material used for passing the cores, except in rare instances, has nothing to do with the core blowing or with the formation of blow holes in the casting. The core may blow on account of the paste getting into the vent passage, but that is carelessness on the core maker's part and clearly is not due to the material of which the paste is composed.

Blow holes in the casting may arise from various causes, oxidized metal, wet sand, hard ramming, or hard cores, that is cores containing too much binder. A careful examination is required to determine which of these factors is responsible. If you are satisfied that the cores are at fault the remedy is to use less binder, larger vents and perhaps a more open core sand.

Melting Copper in Cupola

Question: We propose melting a bronze pump chamber weighing 2200 lbs., which is more molten metal than the capacity of our bronze furnace. Our intention is to melt the required amount of bronze in our 36-inch cupola. As this is the first time we have used our cupola for melting bronze, we are at loss to know how to proceed.

Answer: Melting bronze in a cupola is quite feasible, and you should experience no difficulty, providing a few ordinary precautions are observed.

For a 2200 pound casting we should charge 2500 pounds of copper divided into two charges of 1250 pounds each. The usual bed charge of coke is placed in the cupola precisely as if iron were to be charged The fire is started, and after the bed has been burned through, a thickness of charcoal, approximately 4-inches in depth is placed on top of the coke bed and then the first 1250 pounds of copper is charged. A second thickness of charcoal is spread on top of the metal followed by the usual coke charge. Charcoal again is spread over the coke followed by the second charge of metal.

A mild blast say about 6 ounces will melt the metal satisfactorily, the ladle to receive the metal should be preheated thoroughly, and a few shovels of charcoal placed on the bottom before tapping the copper. The tin, lead and antimony, are added after the copper is in the ladle. An iron rod covered with plumbago is employed to stir the contents, after which the slag is skimmed off and a few handfuls of dry parting sand are thrown over the surface. An iron skimmer also coated with plumbago, should be held close to the lip of the ladle while pouring.

Iron Ore in Montana

Large deposits of iron ore are uncommon in the northern Rocky Mountains, so that considerable interest is attached to some deposits near Stanford, Mont., which were examined in 1918 by a geologist of the United States Geological Survey, Department of the Interior.

The deposits are lens-shaped bodies of rather pure hematite that form a belt along the contact of limestone and an intrusive porphyry. The belt has been traced 7 miles, and although the length of the lenses is not accurately known, the widths range from 5 to 60 feet and one lens is explored 125 feet below the outcrop. Numerous samples that have been taken show the following range in composition: Iron, 35 to 68 per cent; silica, 2 to 13 per cent; phosphorus, a trace to 0.107 per cent. The average of 26 samples from 10 deposits was iron 60.6 per cent, silica 5 per cent, and phosphorus 0.016 per cent.

Existing explorations do not permit an accurate estimate of the probable reserves of the region. Prof. L. G. Westgate, the geologist who made the investigation, concludes that there may be about 2,340,000 tons in the known deposits within 100 feet of the surface. A copy of this report (Bulletin 715-F) may be obtained by applying to the Director of the Geological Survey, Washington, D. C.

Under the new mineral-leasing law it is incumbent upon the Geological Survey, Department of the Interior, to determine the geologic structure of producing oil or gas fields and to divide the coal, phosphate, and oil-shale lands of the public domain into appropriate leasing units.

Bill Makes a Loam Mold for a Cast Iron Pot

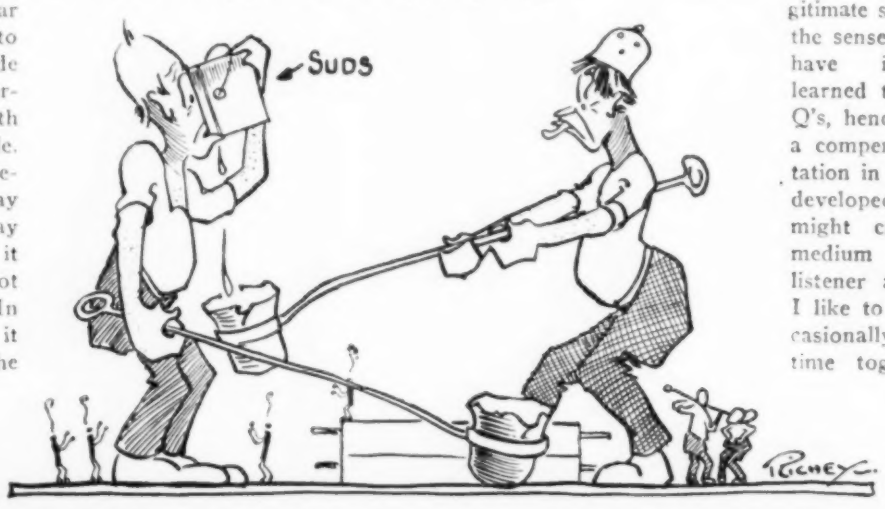
BY PAT DWYER

AMONG the many sayings wise and otherwise prevalent with those tiresome people addicted to quoting from books of old saws and older proverbs is the one to the effect that every human being swallows a peck of dirt in the course of his life. I never have questioned the accuracy of this statement, partly because, so far as I know, no statistics are available to support either one side or the other of a controversy of that character; and partly because I never felt particularly interested. A peck of dirt considered by itself all in one lump is quite an item, but spread out over a period of three score years and ten, which to save you the trouble of figuring it out for yourself is equivalent to 25,550 days, it is evident that the daily quota is not of sufficient volume to warrant the average citizen in retaining the exclusive services of a medical specialist. In fact the statement may be classed with other forms of statistical information so cheerfully and freely handed out to a grateful public by some of the gifted writers who contribute to the bulwark of our liberties—the free and untrammeled press.

For instance if John D's wealth was converted into dollar bills placed end to end and side by side it would form a girdle around the earth about a mile wide. As an abstract statement of fact it may be true or it may not, I never figured it out, but it does not mean anything. In the first place it would require the services of an army of men greater in numerical strength than the combined standing armies of Europe to prevent these dollar bills from acquiring wings and flying away and in the second place while our venerable and esteemed fellow citizen has been accused of many things, I feel I am quite safe in stating that no one ever accused him of leaving dollar bills in an exposed position where they might be acquired by the stray and casual waytarer. Granting, for the sake of the argument, that there is a basis of truth in the peck of dirt theory, no person who ever has visited a foundry will experience any difficulty in believing that if the ordinary person swallows a peck of dirt in the course of an ordinary life time, the man who works in a foundry must swallow an amount equivalent at least to the contents of a railroad gondola. In this connection it is interesting to note that foundrymen all live to a ripe old age and this circumstance taken in conjunction with the foregoing lends a certain air of credence to the well known tradition that a molder never dies. He simply dries up into a puff of dust and blows away.

I spent so many years in the dust and grime of the foundry that my pipes became hopelessly clogged. Had I been equipped with a proper dust arrester or supplied with a suitable exhaust system, for instance such a one as may be seen described and illustrated with great fidelity and detail in the advertising pages of the great family journal in which this contribution eventually will appear; this melancholy condition might have been avoided or at least mitigated to some extent. Unfortunately, since I was not so equipped I now find that I am hopelessly barred from the Chautauqua circuit, from membership in the Fish Peddlers' union and from other like employment of a lucrative character dependent for their success on the possession of a pair of leather lined lungs and a set of vocal organs like those on a steam calliope.

In my young and bare foot days—now happily past and gone, thank goodness—when in company with a band of young heroes similarly attired I followed the annual circus up the main street and down the other street of the old home town, I was wont to refer to the screaming siren at the head of the procession as a steam calli-ope. However, since joining up with fast company—the word *fast* of course being used in its proper and legitimate sense and not at all in the sense which you probably have in mind—I have learned to mind my P's and Q's, hence the calli-o-pee. As a compensation for my limitation in one direction I have developed into what you might call a fairly expert medium and long distance listener and for that reason I like to fall in with Bill occasionally. We served our time together in the same shop and having finished our apprenticeship started out to see the world after the fashion of young



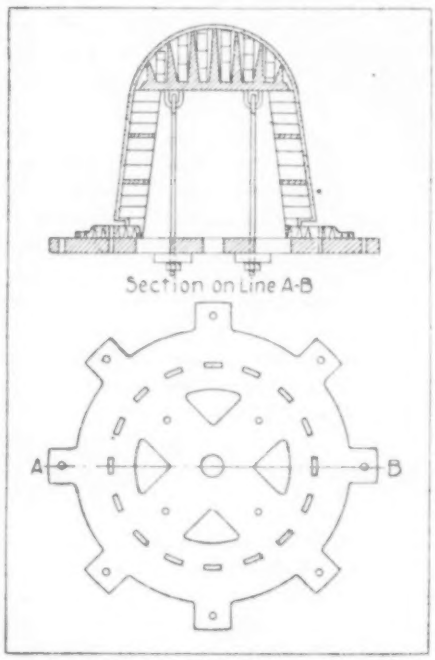
A JUDICIOUS APPLICATION OF FIRST AID AFTER POURING OFF THE HEAT

molders the world over. Bill's journeyings have taken him into many queer and remote places in the years that have elapsed since he threw his first shovel of sand and it is only in recent years that we both have settled in the same town. According to the general law of averages each of us must have inhaled a like quantity of dust, but the result in his case has differed widely from mine. His big booming voice today is as resonant and ringing as that of a deep sea mate accustomed to hurling his voice in the teeth of the wildest tempests that sweep over blue water. When questioned on the subject he modestly attributes his condition to the potent virtues of a brew at one time manufactured in large quantities in Milwaukee. According to Bill a few beakers of this foaming nectar applied internally at noon and a few more at night—few, of course being an elastic term—after pouring off the heat, served to wash away all the dust and dirt accumulated during the day. He claimed many other virtues for this sovereign remedy, but since it has been withdrawn from circulation in a manner of speaking it were waste of time on my part to go further into detail at this time.

Comes Back to His Subject

As the readers of these veracious chronicles are aware, on several occasions recently Bill has dwelt at some length on the different methods in vogue in the manufacture of cast-iron pots. He is a persevering kind of a person with a one track mind in some respects and when he has started on a subject, he likes to continue without interruption. Even when he has been interrupted he has the happy faculty of resuming practically at the point at which he had been cut off. Therefore, I was not unduly surprised when he came around to the house the other night and after conversing for a few minutes on indifferent topics began to describe the method of constructing a loam mold for a large cast iron pot.

"Shortly after leaving home," said Bill, "I caught a job in what was considered at that time the largest and best equipped shop in the East devoted to the manufacture of heavy machinery castings. I have not been down that way in recent years, but I have been given to understand that it has been enlarged and expanded so that probably it still holds the premier position. The gaffer was a widely known, highly competent practical man and like your true artist in every walk of life keenly interested in developing the skill and talent of any of his young men who showed a disposition to learn.



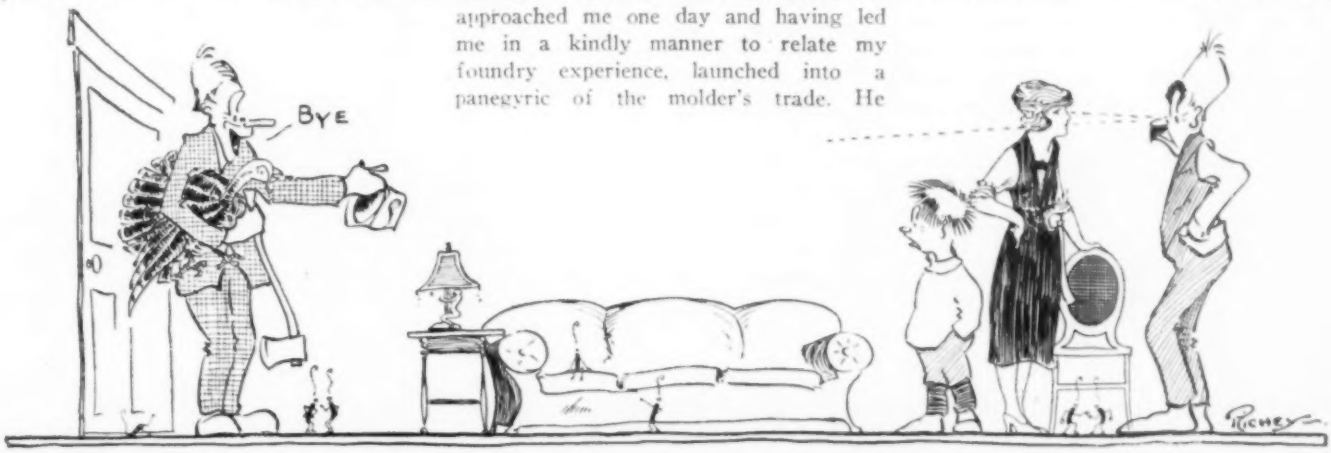
PLAN OF COPE PLATE AND SECTIONAL ELEVATION OF ASSEMBLED COPE

"In those days Curiosity with a capital *C* was my middle name, and this combined with a willingness to work soon attracted the Old Man's attention. He approached me one day and having led me in a kindly manner to relate my foundry experience, launched into a panegyric of the molder's trade. He deplored the fact that so many young mechanics seemed to lack ambition. They seemed to think that having served a four year apprenticeship there was nothing further to learn. I assured him truthfully and with no intention of flattering him personally that I expected to learn a great deal about the business while I worked in this shop under his charge. He said that he was pleased to note my attitude and would be pleased at any time to give me the benefit of his advice. He understood and appreciated my desire to move around and work in several shops before settling down, but said that if I would stay with him for a year during which he purposed to alternate me on the green sand, the dry sand and the loam he would guarantee that when I left I would be a real molder. On the following day he doubled me up with a skilfull loam molder who had learned his trade in one of those famous Scottish shops which turn out castings with a skin like satin. He had been in this country long enough to get the American point of view. He had worked for several years in the old pump shop at The Port, and believe me he had speed as well as skill. He kept me hopping.

Makes His Own Rigging

"He just had received an order for two pots, each 9 feet in diameter by 6 feet deep and from a blue print which he had tacked on the door of his 'wee bit' cupboard he was estimating the extent of the rigging required. It always has been customary for loam molders to make their own rigging, due to the fact that they know what they want and usually are qualified to do their work with little or no supervision. With a pair of trammels and a few bricks he will make a mold for a plate that the ordinary green sand molder would not think of tackling without a pattern.

"In this instance it was decided that we should need one substantial foun-



IN THESE PARLOUS TIMES THE PROBLEM OF HOW TO FILL THE POT TAKES PRECEDENCE OVER HOW TO MAKE IT

dation plate, one cover plate, four building rings and one crown plate provided with long dabbers to support the rounded portion of the mold forming the interior of the pot. We prepared a bed on the green sand floor which served to make all the plates by pouring them on successive days. Thus on the first day after the level bed had been prepared, a wooden wedge was pushed down in the center to act as a support for one point of a pair of trammels. The other trammel point, set to the required radius was employed to scribe a circle on the bed. Eight equidistant points were laid out on the circle using a straight edge and trammels.

"The long straight edge was laid flat on the bed with one edge touching the center mark on the head of the wedge. Marks were made on the circle at the two opposite points where the straight edge crossed the circle and then the straight edge was lifted and set down again in a position approximately at right angles to the first. The position was verified by a square and marked at opposite points after which it became a relatively simple matter to adjust the trammels and bisect the arc of the circle between each pair of marks. I attached no importance to the first position assumed by the straight edge so long as it touched the center mark. It seemed to me that it did not make any difference where the straight edge first was set down so long as the edge touched the center mark.

"On this and other points which up to that time I had considered of little importance I found that my partner held decided views. His trained craftsman's eye could not tolerate anything unsymmetrical or out of line and for that reason he insisted that the straight edge be laid down the first time truly parallel with the line of columns supporting the crane runway. Since that time I have noted that this point of view characterizes all finished molders and the sight of a pattern bedded askew or a foot above or below the floor line offends their sense of propriety as much as a jangling discord offends a musical impresario.

"After the bed had been prepared a few bricks were placed outside the circle line at two of the eight marks. A line of bricks then was set up inside the circle and extending from point to point after which sand was rammed against the face of the bricks to form the retaining wall of the proposed plate. The bricks were removed and moved from point to point until the entire circle had been enclosed. After building a wide pouring basin and setting a 4-inch core in the center to form an opening for the spindle the plate was poured.

"On the following day a similar mold, with the exception that no lugs were provided, was prepared for the building rings to be used in the lower half of the mold. These rings instead of being complete flat circular plates were only about a foot wide and therefore it became necessary to build a retaining wall on the inside and a foot from the exterior wall all the way around. Instead of making two molds each one inch deep for the two plates, one mold was made two inches deep. The mold was poured half full and after the iron had cooled a little it was covered with a thin coating of parting sand and then the remainder of the mold was filled. The same procedure was followed in making the building rings for the upper part of the mold and in this way one mold served to make two castings in each case.

"The exterior of the covering plate was laid out in a manner similar to the foundation plate. Two straight lines, each a foot distant from and parallel to the original center line were marked on the face of the bed from one side to the other. Two similar lines were drawn at right angles and then, having set the trammels to 3½ feet radius, a circle was scribed producing the effect of a wide cross within a circle. The trammels were then reset, this time to a 4-foot, 8-inch radius, and a circle scribed on the face of the bed between the other two. Eighteen 2 x 4-inch cores spaced approximately 18 inches apart were placed on this circle line to form openings in the plate through which the casting was to be poured later. The outside wall of the mold was built up in the manner already described and then the four triangular spaces surrounding the cross in the center were surrounded by bricks and filled with rammed sand. These openings were made in the covering plate to provide a ready means of escape for the gases generated in the interior of the suspended part of the mold when surrounded by molten iron. A piece of 2-inch core was set at each of the four points where the inner circle intercepted the right-angle, center lines. These holes were to receive the bolts attached to the loops in the crown plate or crab. A piece of 2-inch core also was set in the center of two adjoining lugs to provide holes for attaching clevises to roll the core over. The face of the plate from the outside in as far as the circle containing the 2 x 4-inch cores was covered with short dabbers. A 4-inch core was placed in the center to provide a hole for the spindle.

"The crown plate or crab was provided with dabbers from one to two feet in length and therefore it was necessary to prepare the bed with great care and to a greater depth than when making the other plates. The straight edges were left in place, but the sand was dug out in a circle to a depth of 3 feet. It then was riddled and shoveled back into the hole in 6-inch courses, each course being tramped down before adding the following course. The floor of this shop had been dug up so often and so deeply that it was fairly porous, otherwise it might have been necessary to put down a coke bed. After the bed had been scraped off level with the straight edges, a circle was struck to the required diameter and the outside wall built up in the manner described for the bottom and top plates. A center core was set to provide an opening for the spindle. Several other cores were set promiscuously over the face to provide openings for the gas to escape and then a long sharp stick was pushed down in concentric circles about 8 inches apart all over the face. Suitable notches on the stick indicated the distance it was to be pushed down in the various rings. Two long iron bars resting on brick piers outside the mold were employed to support four stout iron loops spaced about 7 feet apart and with their lower points resting firmly on the face of the mold.

"The actual building of the mold presented no unusual features. The foundation plate was blocked up level over the spindle seat and after the spindle and sweep had been lowered into place the brick work which was laid rather open and the interstices filled with fine cinders was built up to a height of about three feet. At this point one of the building rings was set on and then the wall was carried up to within a little less than one brick of the top where the second building ring was set in place. The last course of bricks and half bricks to form a set for the cope was added and then a coating of coarse loam approximately ¾-inch thick was swept all over the face of the mold. This was followed by a thin coating of *slurry* or finishing loam which had been strained through a No. 8 sieve and then the spindle and sweep were lifted out by the crane.

"The mold was lifted by four long slings, engaging the lugs on the bottom plate and embracing the ends of the wings on a 4-way cross suspended from the crane hook. It was placed on one of the carriages and shoved into the oven to be dried. The cope or covering plate then was placed over the spindle seat and after the spindle and sweep had been adjusted the wall was

(*Concluded on Page* 895)

Electric Furnaces for Gray Iron

From the English Point of View

Discussion of G. K. Elliott's Paper at Annual Meeting of Institution of British Foundrymen—Cupola Iron Defended

THE discussion of George K. Elliott's paper entitled, "The Basic-Hearth Electric Furnace and Some Problems of Cast Iron," which was read at the Blackpool conference of the Institution of British Foundrymen, Sept. 14, on behalf of the American Foundrymen's association, brought out some exceedingly interesting suggestions illustrating the British point of view toward the production of cast iron. Some of this discussion is summarized in the report of the Blackpool meeting which appeared in the Oct. 15 issue. Additional details are given in the subjoined further extracts from written discussions submitted to the secretary of the Institution of British Foundrymen, and from the stenographic transcript of the oral remarks at the meeting.

Made Thousands of Tests

H. J. Young, Northumberland Engineering Works, Wallsend-on-Tyne, said:

"It is difficult to get a price for castings which would justify the use of the electric furnace, however good the iron may be. I have made a good many tests on American arbitration test bars having cast over 2000 pairs of which 1134 pairs have been analyzed in duplicate. Of these, 74 pairs gave 0.075 per cent of sulphur or less; 248 pairs gave 0.076 to 0.099 per cent; 469 pairs gave 0.100 to 0.139 per cent; and 343 pairs gave 0.14 per cent sulphur or more. Therefore in over 10 years of work in two foundries, only 6½ per cent of the castings were under 0.076 per cent sulphur. Over 71 per cent contained over 0.1 per cent of sulphur, 30 per cent of the castings having twice as much sulphur as Mr. Elliott indicates is advisable.

"From the list of transverse tests of cast iron before and after treatment in the electric furnace, it appears that where the total carbon is reduced the strength increases, which is to be expected. However, the tests cited do not appear to give evidence wholly in favor of the electric furnace, and my own records of cupola-melted iron (with no electric treatment) contain hundreds of results where the best bars showed from 3808 pounds upward, although the metal contained a higher average content of phosphorus and sulphur than that mentioned in Mr. Elliott's paper. As good results may be obtained with the cupola as, I think, with the electric furnace. We all realize that the use of the electric furnace would enable us to pour at higher temperatures, that slag and such like impurities would separate more freely, that the carbon content could be more easily controlled, and that new constituents could be added; but apart from these facts little can be said at this stage. In a few years' time foundrymen will come down to the fact that cast iron contains sulphur, phosphorus and manganese. If these constituents are taken out you get steel. The cast iron of the future will contain these ingredients; to eliminate them is not necessarily a good thing—certainly the elimination of sulphur is not."

J. Shaw, Brightside Engineering & Foundry Co., Sheffield, wrote:

"Mr. Elliott admits at once that so far as cost is concerned the duplex process is much more expensive than the use of the cupola alone. This leaves two points for discussion. First, are the advantages claimed all due to the duplex process, or could most of them be gained by better selection of material and better cupola practice. Second, is there a sufficient market willing to pay these greatly enhanced prices to keep a duplex plant at fully work?

Cupola Metal Hot

"One of the claims advanced is superheating the metal. That may be granted, but with good cupola working you attain a temperature hot enough for any casting, and as high as most of the local sand will stand up to. If in addition to the first cost of the electric plant, overhead and labor charges, you have to add special sand or composition and extra risk to your molds, you are approaching the cost of steel castings. The possible refining action of the basic-hearth electric furnace constitutes its chief claim for attention so far as gray iron castings are concerned. Mr. Elliott states that it is possible to reduce the sulphur to any limit, given time and a suitable slag, without reducing the carbon, silicon or manganese to any great extent. From inquiries made in Sheffield, this statement is confirmed. But this fact combined with deoxidation, does not account for the 33 per cent gain in strength in the test bars mentioned by Mr. Elliott.

"Take heat No. 1221 for example, we should not in Great Britain call an iron with 3.48 per cent total carbon and 1.92 per cent silicon a strong one. There must be something else to account for the large increase in strength when cast from the electric furnace other than a reduction of 0.077 per cent in sulphur. This latter would, by its action on the combined carbon, weaken the iron. Against this must be placed the reduction of total carbon to 3.38 per cent and silicon to 1.82 per cent, together with an increase in the ratio of combined carbon to total carbon. These latter factors would account for part of the increased strength. May I suggest that higher casting temperature, but chiefly the alteration of the graphitic carbon to the temper carbon form are the principal causes for the increased strength. The only cupola metal that would be considered a strong one in England is heat No. 8172. Unfortunately, no test result for this cupola iron is given.

"In heat No. 8182, the total carbon is 2.77 per cent for the cupola metal. So far as I can learn nothing so low has ever been recorded in Great Britain. It is becoming more and more recognized that low total carbon is one of the chief causes for a strong iron, and I think Mr. Elliott might, with justice, have put this forward as one of the advantages of the electric furnace. To sum up, Mr. Elliott has put before us a large amount of valuable information, and in most cases has proved his points. Whether there is a market for castings of such greatly enhanced cost bearing in mind the higher tests obtained from cupola metal in England, is for each foundryman to decide for himself."

Electric Furnace Beneficial

J. E. Hurst, Hadfield, near Manchester, said:

"The duplex method proposed by Mr. Elliott brings the electric furnace more nearly to the level of a commercial proposition as far as the iron foundry industry is concerned. The improved transverse strength

values given by Mr. Elliott would be expected from existing knowledge of the electric-furnace treatment of cast iron. We are of opinion that Mr. Elliott attaches undue importance to the presence and effect of iron-oxide and the influence of the electric furnace on this constituent in cast iron. Evidence is still lacking regarding the existence of iron oxide (apart from slag) in cast iron, let alone any influence on fluidity and condition of the carbon which Mr. Elliott ascribes to it. To our mind the reduction in total carbon content of the iron after the electric furnace treatment and the considerably increased casting temperature are sufficient in themselves to account for the increase in transverse strength figures noted.

Total Carbon Reduced

"Added to this the reduction in the sulphur content of the cast iron as a result of the refining treatment at the electric furnace stage, by virtue of the reduction in amount of inclusions present, would also add its quota of influence to the increase in strength value. It will be noticed that in all cases except two, Nos. 1721 and 8172, a reduction in total carbon is recorded after the electric furnace stage of the treatment. Two of these cases of reduction in carbon have been effected by the addition of mill scale iron-oxide, and in the remaining cases the reduction is presumably the effect of the normal working of the electric furnace. In the two examples, Nos. 1721 and 1872, a silght increase of 0.01 per cent in the total carbon is recorded. In both these cases an addition of ferrosilicon has been made, and in No. 1872 a further addition of ferromanganese was recorded. There is insufficient data to enable the reason for this to be ascertained, but whatever the explanation, it is significant to note that the exent of the increase in transverse strength in heat No. 1721 is the lowest recorded.

"The increase in hardness consequent upon the reduction of sulphur is a point of considerable interest, and we are in agreement with the general conclusions of Mr. Elliott that a duplex process of this nature is an ideal method of producing cast iron of high quality. The industrial application of the electric furnace in this manner is well known to be entirely a matter of cost, and we are sure that everyone who has the interests of iron-foundry metallurgy at heart will sincerely hope for the time to come when the conditions render the application of such duplex processes possible."

F. J. Cook, Rudge & Littley, Ltd., Birmingham, wrote:

"All who had an active part in the formation of the British Foundrymen's association will remember with gratitude the great assistance received from the American Foundrymen's association in general, and from Dr. Moldenke, secretary, at that time, in particular, and the annual exchange of papers between the two associations, which is now an accomplished fact, cannot fail to be of interest and profit to both.

"There appears to be a difference of opinion between American and British metallurgists concerning the amount of phosphorus and sulphur allowable in strong irons. Mr. Elliott states, 'the irons of greatest strength contain only a small amount of phosphorus', and while there is nothing definitely stated as to what is meant by 'a small amount' or 'irons of greatest strength,' the general opinion in America seems to place the limit of phosphorus at 0.5 per cent. In Britain one has no difficulty in obtaining greater strengths than those given in the paper with not less than 1 per cent phosphorus. We are convinced that the most important point is more with the way in which the phosphorus is distributed throughout the mass than (within limits) the amount present, the phosphorus when segregated tending to weakness.

"Also Mr. Elliott states that sulphur above 0.070 per cent in any ordinary gray iron must be considered dangerous. This is not in keeping Coe's research and experience, which, with an iron containing 1 per cent phosphorus and 1.25 per cent silicon, indicated that the maximum physical properties are obtained when the sulphur is 0.12 per cent.

"Mr. Elliott has laid very great stress (and rightly so) on casting temperatures, and has given some very useful data. If increasingly high superheat were the key to the situation, a very strong point would have been made in favor of the electric furnace, but it has to be remembered that too high temperature is as bad as too low, as shown in the following example taken from Longmuir's research, where an iron had the following analysis:

	Per cent
Combined carbon	0.52
Graphitic carbon	3.40
Silicon	1.78
Manganese	0.28
Sulphur	1.04
Phosphorus	0.27

"When cast at 1400, 1350, and 1245 degrees Cent., respectively, this iron gave maximum tensile stresses of 21,750; 31,600; and 23,750 pounds per square inch respectively; and it must also be borne in mind that a temperature can readily be obtained in the cupola, by good practice, that will give all there is to be gained from casting temperature. This is instanced by Hailstone's temperatures quoted by the author, those results having been obtained under ordinary practice with common work, without any special attempt at superheating.

Low Carbon Interesting

"The table of results is particularly interesting, although there is an absence of evidence given to account for the increased strength of the corresponding irons after passing through the electric furnace. Certainly there is nothing in the difference of the sulphur content to account for it, as claimed by the author. The part played by refining, namely, the elimination of oxides, etc., is difficult to estimate owing to our imperfect knowledge of the subject and inability to estimate the extent to which this has been carried. Microphotographs of the results might have shown some difference in structure. The low carbon content of the cupola-cast metal of heat No. 8182 is interesting to us, as with British gray cast-irons we have been unable to get carbon content appreciably below 3 per cent, except in one or two cases where the drillings have afterward been proved to have been taken from segregated areas.

"The transverse test results, owing to their having been taken on the arbitration bar to which there is no equivalent here, give no comparative idea to the average Britisher. The results have therefore been worked out on a comparison with the same material on bars 1 inch square on 12-inch centers, which is the nearest British test.

"The most noticeable feature of the corresponding results on a 1-inch square bar is the poor results obtained, particularly those from the cupola, which at once inspires the questions as to whether the results given are consistent with those generally obtained with like irons in America, or whether the results have been unduly influenced by casting temperatures. We are more particularly interested in irons with a silicon range from 1.0 to 1.5 per cent, and, unfortunately, the test results for this class of iron, cupola cast, are missing.

"In a foundry with which we are familiar it is not the usual practice to take regular transverse tests, although bars are cast on each cylin-

der, these tests being made only when called for by inspectors, or occasionally for comparative purposes, while tensile tests are made at least from every cast. With irons containing silicon from 1.0 to 1.5 per cent, phosphorus 1 per cent, and sulphur 0.12 per cent, the two latter being more than the author considers safe, and on bars cast 1¼ inch square, machined down to 1 inch square, cast on to the casting and not separate, which ensures all the ill-effects of lowering temperature, there is no difficulty in regularly obtaining better results than those given in the paper for the electric-furnace metal, an average of 25 tests giving 35 hundredweights, or 3920 pounds, on an average transverse-test 1-inch square bar; 37 hundredweights, or 4144 pounds on the highest transverse-test 1-inch square bar; and 34 hundredweights, or 3808 pounds, on the lowest transverse-test 1-inch square bar.

Question Raised

"The question therefore arises as to whether there would be a corresponding increase in test results with this iron if it were put through the electric furnace, and if so, what is the evidence? We fail to find any that would warrant the recommendation of the additional outlay.

E. Adamson, Sheffield, wrote:

"George K. Elliott is to be congratulated on the interesting facts he has given in his paper on the basic-hearth electric furnace and some problems of cast iron. The author is wise to point out that the electric furnace is only of practical use for high-class castings, for, particularly with the present day costs, it is doubtful if the cost of the electric furnace could be kept within $15, or, at parity value, say, £3 per ton. In Great Britain the cost of electricity alone would be anything from 20 shillings to 30 shillings ($3.70 to $5.55) per ton of iron.

"The author states that, 'the hottest part of the melting zone in the cupola is about 2200 degrees Cent.,' and it would be interesting to know what method was used to obtain this figure. It is well known in steelworks practice that silica bricks 'slime' or melt when the furnace is working at 2800 degrees Cent., and it is also known that fire-bricks, which are much less refractory, fuse at a lower temperature.

"A statement by the author is that 'the most powerful factor for fluidity is superheating,' and if he would change this to *one* of the most powerful factors probably a large number would agree with him, but it is a fact that cleanness of iron is also a powerful factor, making all the difference in the fluidity of molten metal as apart from differences in temperature. It may be quite true, as mentioned by the author, that the relationship of liquid contraction and temperature is intimate, but presumably he will agree that liquid contraction has also an intimate connection with fluidity not due to high temperature.

"With reference to the author's mention of nitrogen in cast iron, Dr. T. Baker could not find nitrogen in steel and if this is correct there would probably be none in cast iron.

"With regard to the influence of oxygen, no exhaustive work has been published, although J. E. Johnson Jr. and W. L. Stork show that iron containing oxygen is stronger than iron with less oxygen. Considerably more information is required before a definite opinion can be formed as to whether this phenomenon is actually due to oxygen *per se*, or whether a less quantity of oxygen, as the author suggests, gives the higher test."

Bill Makes a Loam Mold for a Cast Iron Pot

(*Concluded from page 892*)

built up to a height which would accommodate the crown plate or crab. The spindle and sweep were removed temporarily while the crown plate was being adjusted and then returned to place. The sweep was rotated slowly and any point of the dabbers which prevented it from passing were knocked off. Long 1½-inch bolts were attached to the loops in the upper plate, the ends extending through the holes in the lower or covering plate. They were screwed down firmly and then the remainder of the mold was bricked and covered with a coating of loam. By this time the first half of the mold had dried and it therefore was taken out of the oven and lowered into a pit in the floor. Its place in the oven was taken by the second half of the mold.

"After the second half had dried it was taken out of the oven and rolled over by attaching the crane chains to one side and digging a hole in the floor on the opposite side. The core was rolled into the soft bed of sand in the bottom of the hole which prevented any jar. It then was levelled and picked up by the crane and lowered into the other half of the mold which in the meantime had been surrounded by firmly rammed sand. Two stiff binders were laid across the top to supplement the eight bolts extending from the lugs on the top plate to the lugs on the bottom plate and after making up a circular runner the casting was poured. I have assisted at making many pots since that time and the only one I have seen lost was on account of not providing rigging sufficiently strong to withstand the tremendous pressure exerted by molten metal in a casting of this character."

"Well Bill," I said, "I have been on more or less intimate terms with the molding fraternity practically all my life, but you are the first one I ever knew who was willing to admit that he had lost a casting."

"That may be so," said Bill, "but let me tell you something, old son. You can take it from me that the man who never made a bad casting, never made a good one."

Annealing Temperature for Gray Iron

By H. E. Diller

Question—Our iron sometimes is hard and we would like to know if an anneal similar to that given malleable iron would be injurious to the gray iron.

Answer—Gray iron annealed above 550 degrees Cent. deteriorates in strength to some extent. Of course, the higher the temperature is carried and the longer it is held, the more exaggerated will be the bad effect on the iron. An anneal similar to that given regular malleable iron would cause gray iron to be distinctly weak. You could secure the best results by annealing your iron at different temperatures commencing at 550 degrees Cent. and increasing the temperature 50 degrees each anneal until you find the lowest temperature at which your iron will be softened. We cannot state just what this temperature would be as we do not know how deeply your iron is chilled nor its composition. If the chill is quite deep, you may have to go to 750 degrees but if it is only a slight hardening on the skin, 550 degrees Cent. may be high enough for the anneal.

Acquires Pulverized Fuel Engineering Interests

The pulverized fuel department of the Quigley Furnace Specialties Co. has been acquired by the Hardinge Co., 120 Broadway, N. Y. The business will be conducted entirely as before, since the Quigley pulverized fuel engineering department has been taken over practically intact. It is expected that with the experience and manufacturing facilities of the Hardinge company, the latter with its present equipment and augmented staff, will further extend the activities of the Quigley pulverized fuel system. The Quigley Furnace Specialties Co.,

hereafter will devote its attention entirely to its refractory specialities business which has been growing rapidly.

H. A. Kimber, formerly of the Quigley Furnace Specialties Co., is now in charge of the sales of the Quigley pulverized fuel department of the Hardinge Co. L. W. Marso, in charge of the branch office of the Quigley Furnace Specialties Co., 427 Oliver building, Pittsburgh, also now is with the Hardinge Co., and will continue in the Pittsburgh office under the name of the Hardinge Co., but will specialize in handling the Quigley pulverized fuel system. O. M. Rau, formerly consulting engineer to the Philadelphia Rapid Transit Co., has become associated with the Hardinge Co., and will specialize in Quigley pulverized fuel systems as applied to boilers. W. O. Rankin has become associated with the Hardinge company in the capacity of managing engineer of the Quigley pulverized fuel department.

Mold Tractor Link with Green-Sand Core

WHEN one thinks of cores he usually pictures a dry-sand core, a hard dried mass of sand held together with a binder, as most cores are made that way. The green-sand core is coming more and more into use where it is possible to adapt it to the work. In some jobs the under half of the core is made of dried sand and supports the upper half which is made of green sand.

The method one large steel foundry has adopted in making shoes for a crawl-type tractor is interesting. The cope and the drag are made on two separate pneumatic squeezer machines. Set conveniently to the molding machines is a large bench shown in Fig. 1, and one of the foundry cranes carries a box of core sand to this table. As may be noted, the box is placed on a form supported by four legs. The sand is released by a gate in the bottom. Two coremakers work at the bench and furnish cores for four molders. In the illustration, Fig. 1, a coremaker is shown with the drag half of the corebox. The two-plate box belonging to the other coremaker is shown to the left. The two halves of the core are made in separate plates and joined together, then the top plate is lifted off and the bottom plate containing the core is set on a table near the one on which the core was made. The molder who has made the drag brings it to the core and sets it on the plate guided by pins on the flask as shown in Fig. 2. The coremaker turns the whole over and removes the plate. Then the molder who has made the cope sets it on the drag and the mold is complete ready for the pouring and riser boxes. As may be noted from the castings shown in Fig. 2, the shoe or link, as it is called, has the one side almost flat and the other side has two ribs with the edges turned over which make the use of a core necessary. However the side of the core forming the ribs has a broad surface to rest on the drag, the four flat surfaces in the corners of the drag, shown in Fig. 2 forming bearings to support the core.

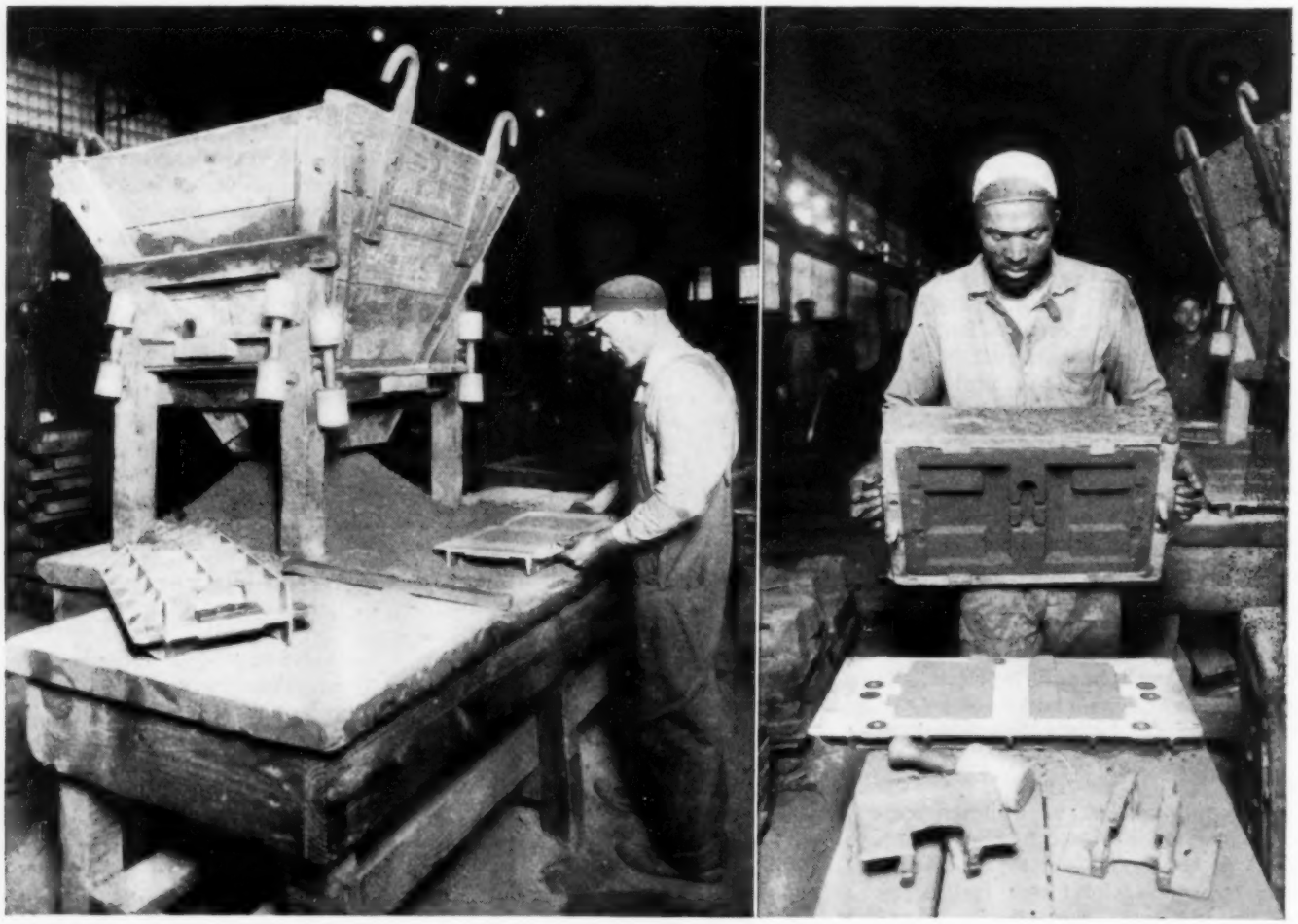


FIG. 1—SAND IS BROUGHT TO THE COREMAKER IN THE CENTER OF THE FOUNDRY IN A LARGE BOX CARRIED BY THE CRANE FIG. 2—THE CORE PLATE IS SET ON A STAND AND THE DRAG IS PLACED OVER IT—THEN THE WHOLE IS TURNED AND THE CORE PLATE REMOVED AND THE COPE ADDED

Devise Bending Test for Malleable

Standard Tension Test Bars Are Clamped in a Vise and Bent Until Rupture Occurs—The Degree of Deflection Is Measured on a Specially Prepared Dial

BY EDWIN K. SMITH AND LOUIS LICHTENHELD

ONE of the most valuable properties of malleable iron is its ability to bend without fracture, when subjected to heavy stresses. From the earliest days of the industry, malleable foundrymen have proved the quality of their product by battering castings into various distorted shapes.

During the past few years the tendency has been toward more scientific methods of testing, and at present, the practically universal specifications for malleable castings call for two determinations—tensile strength, and per cent of elongation. These tests are of unquetsioned value and have come to stay, but it seems possibe that in the pursuit of tensile strength and elongation the essential features; resistance to shock, and ability to bend without fracture, may have been neglected. This is particularly true of certain classes of castings. It is obvious that many railroad, automotive, and agricultural castings must have a high resistance to shock, and on some of the lighter classes of work, ability to bend is of prime importance. For example, some harness castings must submit to strenuous bending operations in the course of manufacture.

The Walker drop machine will give a good indication of the sample's ability to resist shock and any foundry equipped with one of these, and a standard tensile testing machine can get a good indication of the quality of its product. However, some time ago, we came to the conclusion that there should be some simple test for measuring the amount of bending which samples of malleable iron would stand. After some experiments, a square aluminum plate was marked into two concentric circles. On these circles were marked the angular degrees, starting with 0 degrees on the bottom of the outer circle, and running by 10 degree graduations up to 360 degrees. The angles from 360 to 720 degrees are also read on the outer circle, by adding 360 degrees to the angle on the dial. Sometimes, owing to the gates being in the way, it is more convenient to bend the bar in the opposite direction from the usual one. In such cases the angles on the inner circle are read. The bendability dial is shown in Fig. 2.

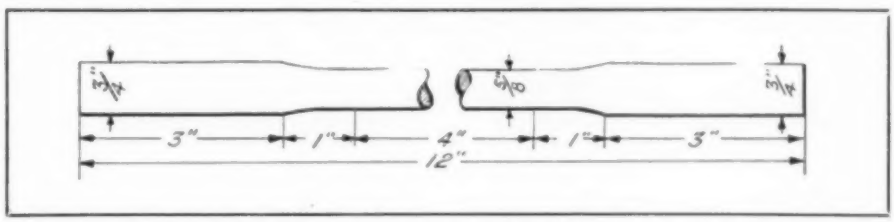


FIG. 1—THE STANDARD TENSION TEST BAR IS USED FOR THE BENDING TEST

In determining the form of test bar to be used, it seemed best to take the standard ⅝-inch tensile bar of the American Society for Testing Materials. Specifications for this bar are shown in Fig. 1. This bar is especially suitable for the bending test, as almost every malleable foundry is equipped for making it. In most cases

The authors are associated with the Lakeside Malleable Castings Co., Racine, Wis., in whose laboratory the tests were made.

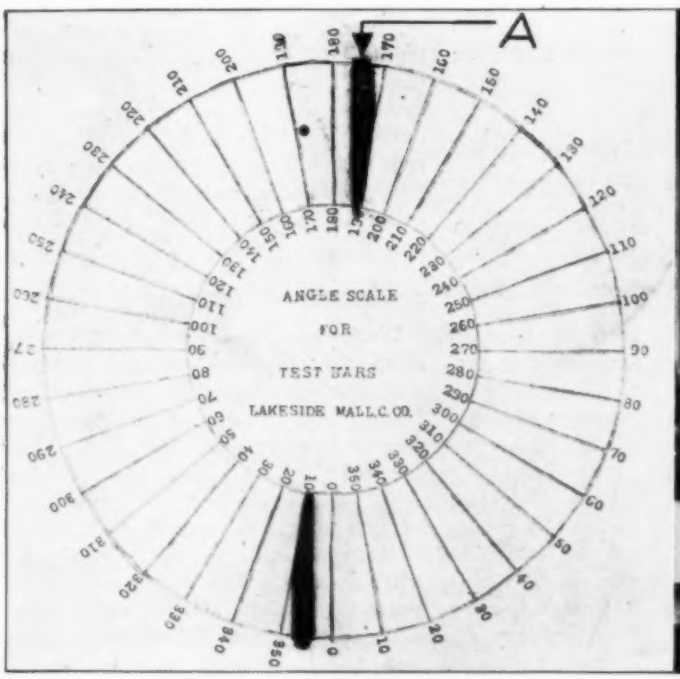


FIG. 2—THE ANGLE OF DEFLECTION OF THE TEST BAR IS MEASURED ON A CIRCULAR DIAL DIVIDED INTO SEGMENTS
FIG. 3—THE TEST BAR IS HELD IN A VISE AND BENT WITH A PIPE

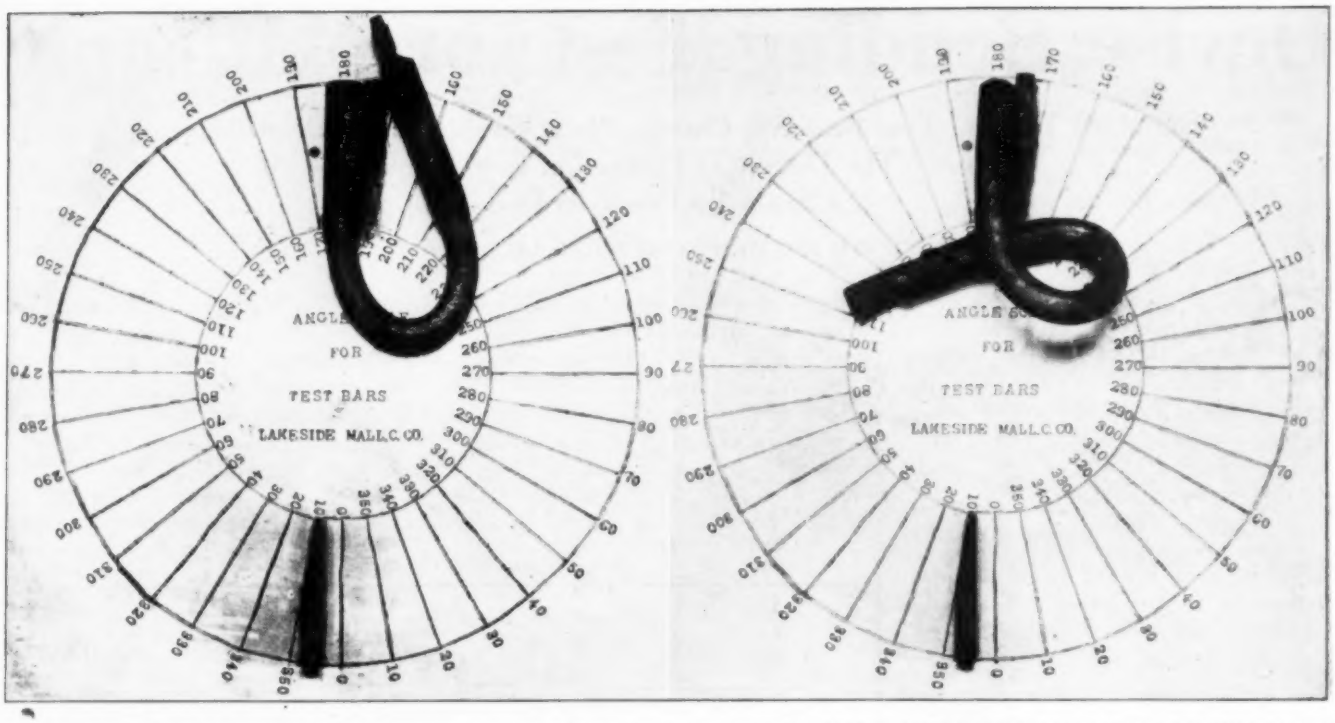


FIG. 4—THIS BAR SHOWS A DEFLECTION OF 178 DEGREES FIG. 5—THE ANGLE OF DEFLECTION OF BARS WHICH DO NOT REACH THE OUTER CIRCLE IS MEASURED BY THE PROLONGATION OF THE END—THE ANGLE OF THIS BAR IS 265 DEGREES

a number of such bars are made from every cast, and an extra one for the bending test is little expense.

The test is made as follows: Clamp the bar tightly in a vise, about an inch from one end allowing the greater length of the bar to stand above the vise.

Place a length of pipe over upper end of test bar, covering about two inches of it. A 46-inch length of 1½-inch pipe is suitable for the purpose. Then pull down on the end of the pipe. The great leverage obtained enables the operator to bend the bar with ease. A bar, bent to about 90 degrees is indicated in Fig. 3.

When the test bar has bent until the pipe touches the vise, it is removed and set in the vise, below jaws. The vise is then tightened, until the ends of the bar meet. Then one end of the bar is clamped in the vise, so as to project from the side of same. The pipe is again put in position, and the bar is bent until it just starts to fracture.

To measure the deflection the bent bar is placed on the measuring dial so that one side bears on the riveted guide, *A*, Fig 2.. The angle is read from the point where the outer circle is cut by the edge of the test bar, or by a prolongation of this edge. The edge used in measuring the angle is on the same side of bar as the edge which is pressing against the guide *A*.

Fig. 4 shows a bar bent to 178 degrees, while Fig. 5 indicates a bar which has been bent to an angle of 265 degrees.

As an indication of ability of malleable iron to bend, this test has given reliable results. By it, the foundry metallurgist at once can, detect any incipient tendency of the product toward lack of bendability. He then can remove the cause of such a condition long before it would become noticeable by other tests.

The whole method requires little equipment, except an inexpensive dial plate, and is so simple that anyone can get accurate results.

Defective Castings To Take Scrap Freight Rate

The trunk line freight inspection bureau has issued the following circular setting forth the ruling of the official classification committee in allowing the scrap freight rate to apply to defective castings having value for remelting purposes only:

"Insofar as defective castings are concerned the conclusion of this committee is that, if shipments are offered for transportation described as 'defective castings having value for remelting purposes only' they should be billed at the specific rating applicable on 'castings' but if evidence is furnished, after arrival at destination, that they are actually melted for the scrap content, this committee will raise no objection to the charges being reduced to the scrap iron ratings; per contra, if no such evidence is produced, the ratings for the specific kind of castings will maintain thereon.

"If the shipments are presented for transportation as 'castings' or even as 'defective castings' they should be billed as castings and no reduction in the charges will be authorized thereon, this for the reason that the carrying lines assumed the responsibility for their transportation as castings."

Auto Vehicles Registered

A total of 9,245,195 passenger cars, trucks and commercial vehicles, and also 28,114 trailers and 177,234 motorcycles were registered in United States during first six months of 1921. From registrations and licensing of chauffeurs, operators, etc., the several states collected gross revenue of $108,213,-165.

Erects New Car Shops

Work has been started on tearing down the old buildings at the American Car & Foundry Co. at Terre Haute, Ind., which were partially destroyed by fire some time ago. When the old buildings have been wrecked, work will begin on the construction of new structures, according to the announcement made by E. D. Buick, district manager. The new buildings will house the machine and blacksmith shops. These shops are to be entirely new and modern. No attempt will be made to reopen the car shops until the building has been completed.

How and Why in Brass Founding

By Charles Vickers

Casting Large Manganese Bronze Bushings

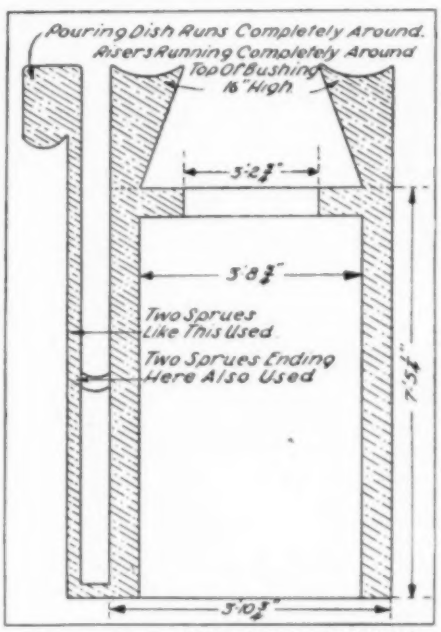
We have been trying to make a bushing of manganese bronze; weighing approximately 12,000 pounds, a sketch of which we enclose to illustrate our method of gating the same. The casting when taken from the mold, appeared to be perfect, but upon machining, gas pockets appeared which seemed to run through the whole casting. The gas bubbles or pockets did not seem to show signs of oxide.

The mixture used is the same as that used for propeller wheels namely: Copper, 60 per cent; zinc, 39.50 per cent; manganese, 0.15 per cent; lead, 0.10 per cent, and tin, 0.10 per cent. The bronze was melted in a nonerucible, oil-fired furnace, from which it was tapped into a ladle, in the same manner as tapping iron from a cupola. We will appreciate your advice in regard to anything we should carry out to get sound castings.

For a manganese bronze, the mixture given is open to severe criticism, as there is no question but that it will be low in both tensile and elongation, and though used for propellers is entirely unsuited for this application. We note that no aluminum is mentioned, and without this element we should expect the casting to show defects after being machined. No doubt the missing 0.15 per cent was aluminum, in which case the alloy will run sound as far as the metal is concerned. If the aluminum content has been neglected, add at least two ounces per hundred pounds of alloy.

In these bushings, either the core or the mold is in the majority of cases the cause of the porosity because either the one or the other is too dense for the gases generated, to escape freely, with the result they pass through or into the metal, and being there trapped are found when the skin of the casting is removed.

For a mass of metal 12,000 pounds in weight, the mold has to be made of different sand than that used for small castings. The use of the ordinary sand piles found in a brass foundry will always cause trouble with a casting of this weight. What is wanted is a sand like No. 2, Lumberton, possibly mixed with a proportion of Millville gravel, with a minimum of binder for the mold. After the pattern is drawn, the mold should be slicked, then blackwashed and dried, making a solid, strong but porous mold which should be poured as warm as possible so no moisture will accumulate in the walls. The core must be made of an open sand, well blacked externally, and if the core is solid, it must not be assumed that one event in the center, as used in small stock cores, will carry away the gases. Use plenty of fine cinders in the core, and figure that a clean pathway must be made for the escape of the gases, from an area no more than an inch inward from the surface of the core where the metal will rest. The gases must be carried away from the surface of the core, and from the surface of the mold so freely that it will be the only way they will take, because the easiest way. Otherwise they will try to pass through the metal and the casting will be of no value. It is imperative the metal lies against the mold and core without a sign of a *shiver*. *Shivering*, *bubbling* and *spitting* of the metal as it comes up indicates the mold or the core, or both are too impervious and that gas is entering the metal.


Pouring Dish Runs Completely Around.
Risers Running Completely Around Top Of Bushing 16" High
5'-2 3/4"
5'-8 3/4"
Two Sprues Like This Used
Two Sprues Ending Here Also Used
7'-5 1/4"
5'-10 3/4"
MOLD FOR MANGANESE BRONZE BUSHING

In your vicinity, no doubt there is an iron foundry accustomed to making large and heavy castings; no doubt some in dry sand. We suggest you get from them some dry sand facing used for heavy castings, also some of the coarse molding sand for a backing, and make the mold of this, and dry it well. If a loam core can be made, this would probably be best, but a little ingenuity, combined with a knowledge of the importance of providing instant escape for the gases generated at the surface of the core where the metal touches will solve this difficulty. If the metal lies quiet as it comes up in the mold, it will be a certainty the casting when machined will be sound.

When pouring large castings of manganese bronze, have a large runner basin and set dry sand cores, bonded with silicate of soda, at the mouths of the various sprues. Flare the opening, in the cores with the narrow part downward, and fit plugs of core sand bonded with silicate of soda, to the sprue throats in the cores. Attach the plugs to long iron handles, and have men holding them when the metal is poured into the basin. When the basin is filled with metal, have the plugs leading into the bottom gates lifted, and later according to judgment, have the plugs to the gates higher up on the casting, lifted. Rehearse the pouring performance so the men know just what to do and when to do it. After the metal starts entering the mold, keep basin filled.

Recovering Lead from Old Battery Plates

We contemplate using lead obtained from battery plates and would appreciate any information you may give us in regard to the most practical method for reclaiming the lead from this waste. How is it melted, separated and cleaned?

To recover all the available lead and to reduce the oxide and sulphate attached to the plates a considerable knowledge of the smelting business is required and this is not generally available in a foundry. The best that can be done is to recover the metallic lead. The plates cannot be melted in crucibles

with the dross floating to be skimmed off before pouring the metal. The oxide would destroy the crucible in one heat by cutting it through at the slag line. The most practical plan would be to build a small reverberatory furnace, an oven like affair with a sloping hearth onto which the plates could be stacked and heated. The liberated lead then would run down the slope to the open tap hole and thence into the ladle. The dross could be raked out at intervals, accumulated and sold to refiners.

The dross is reduced to a metal by a flux of salt, fine coal, glass and tin plate intimately mixed and smelted in a reverberatory furnace at a temperature between 1000 and 1500 degrees Fahr.; or it may be treated in the blast furnace with tin slags and iron which results in an alloy of lead and tin.

Hot Sand in Flask Causes Porous Castings

We have had difficulty due to porosity of small brass castings of composition eighty five, three fives, and we are sending a sample for your inspection. We melt in an openflame oil-fired tilting furnace, and for fuel use a light Pennsylvania oil, having sulphur under 0.5 per cent. The oil is used under a pressure of 30 pounds, with air pressure of 6 ounces. We add a little phosphor copper; about 0.10 per cent of the 15 per cent phosphor copper. The heats of 700 pounds require about one hour to melt, and the castings are poured at a temperature within the range, 2000-2100 degrees Fahr. We will appreciate any suggestions you may be able to give us.

The sample casting shows porous on one side only, therefore, it appears likely the porosity is due to some molding condition such as hard ramming of one half of the mold; also it may be caused by wet sand. By wet sand we do not mean sand that is too damp in the pile, but sand that is being used hot to fill up the flask. This hot sand will steam through the cold sand facing and will fill the mold cavity with steam which will condense therein and produce the same effect as molding with wet sand. As the trouble has come up recently, there is a great possibility it is due to the hot weather, the sand holds its heat after casting, and then molds are made with hot sand backing. It does not appear the melting part is at fault; the sulphur is low, the metal is deoxidized, and the melting conditions are normal. It does not pay to economize on molding space, which means using the sand many times over in a day. Note if this condition prevails; if not, then there is something else wrong with the molding; if the metal was aerated in the furnace the castings would be covered with holes all around; the holes would not be clustered on one side.

Brass Defects Due to Included Dross

We are sending you two small simple brass castings, and will greatly appreciate any suggestions you may make that will aid us in improving the quality of the castings. You will note that both are defective.

In the case of one of the castings a large patch of dross has been uncovered by turning off a portion of the stock and in the case of the other a part is threaded and the tops of the threads on one side, presumably the cope part, are filled with dross, making them jagged. The source of the defects lies in the metal. It is drossy and contains iron, and it would appear that a jumble of red and yellow brass with possibly a percentage of borings had been melted without regard to the analysis of the final mixture. The alloy is too hard and irony to be economical, as the loss and the cost of machining will increase the cost beyond that of all new metal. The following new mixture would work out cheaper:

RED BRASS MIXTURE

	Per Cent
Copper	83.00
Zinc	10.00
Lead	5.00
Tin	2.00

A possible improvement of the scrap metal being used would be to use 50 per cent scrap with 50 per cent of a mixture of copper, 84 per cent; zinc, 8 per cent, and lead, 8 per cent.

Causes of Spots on Brass Ornamental Castings

We have experienced some difficulty with spotting out, in the case of ornamental castings, one of which we send for your inspection. This casting has been dipped and polished and you will note the center is badly spotted. We will appreciate any suggestions you may be able to offer in regard to the cause of our difficulty.

The difficulty is caused by defects in the casting due to metallic oxides which have entered the mold with the metal. In the sample sent the comparatively large and heavy center received the first rush of the metal when it was cast, and some dross being carried by the metal lodged and produced a porous spot. The same thing happens in the case of valves and other castings that leak when under pressure. In the present instance, when the casting is dipped, some of the acid liquor seeps into the porous spot and remains. Then, after the casting has been polished, this acid oozes out with the result seen. This is called spotting out.

As prevention is in all cases better than cure, it would be advisable to add a small amount of deoxidizer to the metal to eliminate the oxide of copper or other metal as much as possible, for the less dross in the metal, the less chance will there be of any getting into the castings. Also, if the spotting-out appears most frequently on the large surface, the gating should be changed so that part of the casting will not be filled at the first rush of the metal.

The use of some skimming device to hold back the dross will materially assist in getting cleaner castings. The fault is entirely a foundry fault. In the case of the sample, the specks of dross have penetrated entirely through the casting and the spotting-out is visible on both sides.

In addition to using a deoxidizing agent in the metal, after the acid dip, the castings may be dipped in a neutralizing bath of lime water, or similar chemical allowing them to remain sufficiently long for the alkali to penetrate to the acid. The castings then will be dried by hot water, after which they should be placed in an oven heated to about 230 degrees Fahr., with the idea of expelling all moisture from the pores of the casting. When the castings are cool, they can be polished, and no spotting-out will be evident.

Flux for Aluminum Alloys

We would like to learn what is a good flux to use when melting aluminum alloys. How is sal ammoniac for that purpose?

An excellent flux to be added on the surface of molten aluminum is zinc chloride. The fused zinc chloride should be used. A piece the size of a hickory nut is generally sufficient for an ordinary pot of aluminum. The chloride is tossed onto the surface of the aluminum and is stirred around. The action of the chloride is to disentangle the aluminum from the dross. The dross is reduced to the condition of dust and can be removed from the aluminum, leaving the latter free of the thick metal which is often found mixed with the surface layer of melted metal.

Sal ammoniac is sometimes used for the same purpose, but it is not considered as good as the chloride of zinc. Sal ammoniac is chloride of ammonium. Another chloride sometimes used is chloride of sodium; common salt. However, this is not as satisfactory as sal ammoniac.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

ROUTINE ANALYTICAL METHODS

(*Continued from data sheet No. 404*)

Malleable Cast Iron

Two types of samples are taken of malleable iron; the one is from the hard iron to act as a guide for the next heat and the other is from the annealed casting.

The hard-iron sample for analysis may be taken from one of the castings, or a special bar may be cast. A bar 3 inches square, 7 inches long with a notch cast in the middle across one side is comparatively easy to drill and when the test piece is broken at the notch the cross section gives an indication of the composition of the iron. If the silicon or manganese is too high a mottled appearance will be shown, and the amount of carbon in the iron will be indicated by the size of the area of shrinkage in the center of the cross section.

The hard iron can be pulverized either by drilling with a flat or a twist drill at low speed, or by pounding in a diamond mortar. The use of an air hammer with a pestle attachment, as described by F. L. Hiller in the May 15, 1921 issue of The Foundry

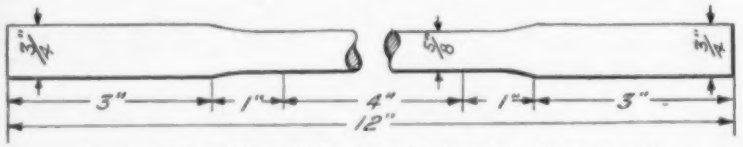


FIG. 3—STANDARD MALLEABLE IRON TENSION TEST BAR

reduces the labor of this operation. Whether the sample is taken by drilling or by pounding in a mortar care must be exercised to see that all sand is ground off the surface of the piece to be tested.

Drillings from the bars cast for physical test can be used for analysis after they come from the anneal. The standard dimensions of these bars as adopted by the American Society for Testing Materials are shown in Fig. 3.

Cast Steel

Drillings for analysis of cast-steel heats can be taken from castings or small open-sand test pieces may be used. Steel burns the sand more than iron does and the drill must be well below the surface of the test piece before the sample is taken.

Pig Iron

Every carload of pig iron should be sampled by breaking not less than six pigs taken from different parts of the car and taking equal amounts of drillings from each pig. These drillings should be secured with a ½-inch drill half way between the center and sides of the cross section of the freshly broken pig. The same precautions should be taken to secure an even sample, as have been indicated under *Gray Iron*. Care must be taken with the pigs to see that no rust or sand gets in the sample.

(*Continued on data sheet No. 406*)

ROUTINE ANALYTICAL METHODS

(*Continued from data sheet No. 405*)

DETERMINATION OF SULPHUR

Principle—Sulphur occurs largely as sulphides of manganese and iron. The two general methods for sulphur in iron and steel are gravimetric and volumetric. In the gravimetric method the sulphur is oxidized and changed to iron or potassium sulphate after completely destroying the nitrates by baking and evaporation with HCl. An excess of barium chloride ($BaCl_2$) is added to the slightly acid solution and the insoluble barium sulphate ($BaSO_4$) allowed to settle, then filtered off and weighed. In the volumetric method the sulphide is decomposed by acid. The hydrogen sulphide (H_2S) gas evolved is passed through an ammoniacal solution of cadmium chloride ($CdCl_2$). Yellow cadmium sulphide precipitates. An excess of HCl is added, freeing the H_2S, which is titrated with iodine, using a starch indicator.

Gravimetric Method for Sulphur

Procedure—Place a 5 gram sample plus 40 c.c. conc. HNO_3 plus 4 to 6 c.c. conc. HCl in a 400 c.c. beaker. Heat *slowly* on hot plate until nearly dissolved. Add about 0.5 grams $KClO_3$ (sometimes the chlorate causes sputtering if added quickly to hot solution) and evaporate on hot plate just until brown fumes disappear. The hood window should be kept closed during the evaporation as chlorine is evolved. Add 30 to 40 c.c. conc. HCl and heat until iron salts are dissolved, evaporate until only 2 or 3 c.c. of HCl are left and $FeCl_3$ begins to crystallize out. Add 20 c.c. conc. HCl and about 50 c.c. of water. Warm until all iron is dissolved, filter (No. 4 Whatman filter paper) and wash well with hot H_2O (total volume must not exceed 250 c.c.). If there is a precipitate in the filtrate at this stage it is probably due to titanium and must be filtered off. Heat just to boiling and add 25 to 35 c.c. 10 per cent $BaCl_2$ solution (100 grams barium chloride plus 900 c.c. H_2O) slowly and with stirring. Allow to stand cold over night. Warm and filter the precipitated barium sulphate ($BaSO_4$) (No. 44 Whatman paper) washing thoroughly with hot H_2O and hot dilute hydrochloric acid until free from iron stain. Ignite in weighed crucible. Precipitate should be pure white and contains 13.734 per cent sulphur. Therefore the weight of $BaSO_4$ x 0.13734 ÷ 5 equals the percentage of sulphur in a 5-gram sample. For approximate calculation the weight of precipitate x 2.75 gives the percentage of sulphur.

For extremely accurate work all filtrate from the $BaSO_4$ precipitate should be re-evaporated and $BaCl_2$ added to precipitate any SO_4 which might have come through the filter in the washings.

(*Continued on data sheet No. 407*)

Study Effect of Lead on Gun Metal

Work of Previous Investigators Is Reviewed and Results of Recent Experiments Are Tabulated—Both Sand and Chill-Cast Bars Were Tested—Microstructure of the Metal Is Studied

BY R. T. ROLFE

THE effect of lead in this alloy has been previously dealt with by H. S. Primrose,* J. Dewrance,† F. Johnson,‡ and the present author.§

Primrose's experiments were on chill castings, the influence of this impurity being studied up to a proportion of 3 per cent, the lead replacing an equivalent weight of copper. The requisite amounts of lead were added to the normally pure gun metal to produce in the final alloys the proportions given in the following table. No data are given as to casting temperatures and conditions. The following results were obtained:

Mark	Lead, Per cent	Tensile strength, pounds per square inch	Elongation, Per cent	Brinell hardness	Melting point degrees Cent.
..	...	41,660	18.4	70	998
A	0.5	38,980	16.3	65	965
B	1.5	34,280	17.1	60	920
C	3.0	33,380	12.5	55	870

Dewrance's work dealt with green-sand castings, the addition of lead being carried as far as 16 per cent, always at the expense of the copper. The results were as follows:

Lead, Per cent	Tensile strength, Pounds per square inch	Elongation, Per cent
0	21,840	Not stated
0.5	36,960	13.2
1	33,820	9.75
2	34,170	10
3	35,840	13
4	33,600	9
6	Not stated	12
8	30,240	10
10	32,030	10
12	29,790	7
14	30,020	9
16	28,000	5

Dewrance also claimed for leaded gun-metal an increased resistance to the action of high temperatures than in the case of the lead-free alloy, and stated that gun metal containing 0.5 per cent of lead could be used without loss of strength up to 550 degrees Fahr., while with the material of normal composition an enormous falling off, both in strength and ductility, occurred at a temperature of about 750 degrees Fahr. As the results obtained by the admiralty with the same two alloys do not confirm this contention, the matter is in some doubt.

Johnson's results were from small chill castings. His results are shown in Table I.

From a study of these papers in particular, and from the general literature on the subject, it appeared that, in spite of the previous work, the exact effect of lead in gun metal was still quite uncertain. This opinion was confirmed by a consideration of the following varied opinions extracted mainly from the papers in question or from the discussion thereon:

F. Johnson: "Lead does not appear seriously to affect the mechanical properties, although it is possible the resistance to shock is lessened."

H. S. and J. G. Primrose:* It has even been claimed that with half of 1 per cent of lead in gun metal the tensile strength of the alloy is improved, but this is very doubtful."

W. Ramsey: "Even 0.5 per cent of lead would reduce the tensile strength very materially."

A. E. Seaton: "At one time lead was looked upon as a public enemy, but now everybody was proving what a good friend it really was."

The author: "The author has also found that 1 per cent of lead does not affect the quality appreciably."

Owing to this uncertainty, it was decided to carry out a further series of tests on the same lines as in the case of the antimony and arsenic investigations previously published.†

A number of synthetic alloys were prepared, showing a progressive increase in the proportion of lead, both sand and chill castings being made side by side. Casting temperatures were determined, and complete analyses were made of all the different compositions, these being correlated with the mechanical test results; soundness of castings, hardness, Stanton impact values, and with the microstructures. Apart from the complete analyses of all alloys, complete analyses

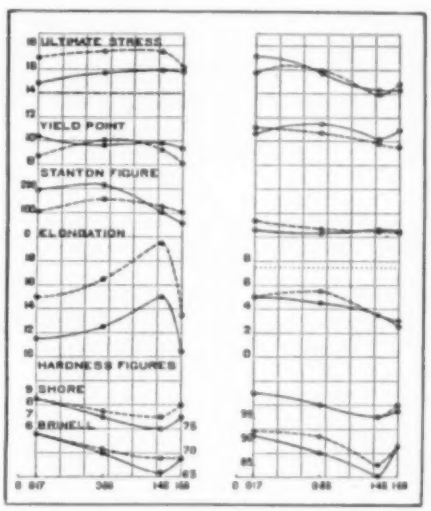


FIG. 2—SAND CAST FIG. 3—CHILL CAST—RESULTS FROM MELTS, FULL LINES; REMELTS, BROKEN LINES

were made of all the original constituent metals used.

In the case of each alloy, the residual metal from each melt, after the requisite sand and chill cast bars had been poured was cast into ingots. These were later remelted, without any addition being made, and further bars were cast, while again casting temperatures were determined and analyses made. This procedure afforded an additional check upon the influence of the lead and also gave information as to the variation in composition caused by

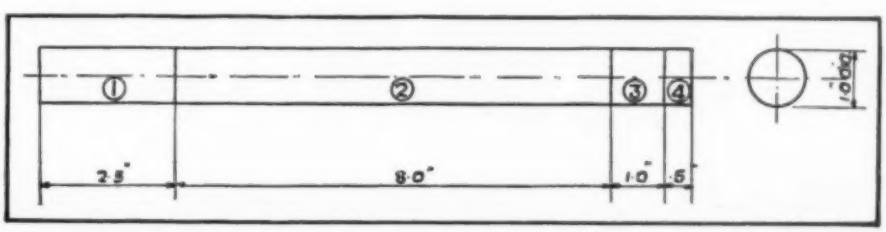


FIG. 1—METHOD OF CUTTING UP BARS—1, BOTTOM, RESERVED—2, TENSILE PIECE—3, HARDNESS PIECE—4, PIECE FOR MICROSCOPIC TEST

Paper presented at the meeting of the British Institute of Metals held in Birmingham, Sept. 21 and 22, 1921.

*Original reference not known, but requoted in Johnson's paper below (p. 172); also in "Gun-Metal and Brass Founding," H. S. and J. S. Glen Primrose, 1st ed., 1920, p. 239.

†"Bronze," *Journal of the Institute of Metals*, No. 1, 1914, vol. xi. p. 214.

‡"The Influence of Impurities on the Mechanical Properties of Admiralty Gun-Metal," *Journal of the Institute of Metals*, No. 2, 1918, vol. xx. p. 167.

§"The Effect of Arsenic, Antimony, and Lead on 88:10:2 Gun-Metal," *Journal of the Institute of Metals*, No. 2, 1918, vol. xx. p. 263.

*"Gun-Metal and Brass Founding," 1st ed., p. 234.

†"The Effect of Increasing Proportions of Antimony and of Arsenic Respectively upon the Properties of Admiralty Gun-Metal," *Journal of the Institute of Metals*, No. 2, 1920, vol. xxiv. p. 233.

remelting. The approximate proportions of lead aimed at were, respectively, none, 0.5 per cent, 1.0 per cent, and 1.5 per cent.

Table II shows the composition of the metals used which were of the following brands:

Copper: Rio Tinto best selected.

Tin: Messrs. Williams, Harvey & Co's lamb and flag brand.

Lead: Messrs. Quirk, Barton & Burns, St. Helens, brand as stated.

Zinc: Messrs. Suzuki & Co.'s rising sun brand.

It will thus be seen that the tin, lead, and zinc were of a good degree of purity. The Rio Tinto copper, which was the only brand available at the moment, contained 0.18 per cent of lead, an exceptionally high figure for this brand. For experiments on the effect of lead, this feature was of course of little importance. It also contained 0.46 per cent of arsenic, which, as has been previously shown, is not unusual in this copper. The result was that all the lead alloys contained nearly 0.5 per cent of arsenic. However, as this appeared to lead to no particular falling away in the quality of the nominally lead-free metal, and as exactly the same proportion occurred in each of the leaded alloys, which again showed a marked variation in properties with the variation in the proportion of lead, it was not considered that the presence of the arsenic could have any masking effect on the true action of the lead.

In the manufacture of the alloys a 50 pound pot was used, the copper being melted first, the tin and lead being then added, and the zinc last, just before pouring. A pit fire was used, operated by natural draught. The time of melting, from the start to pouring into the molds, was approximately 2¼ hours. No flux or other covering material was employed in any case. The size of the bars, both sand and chill, was 1 inch in diameter by 15 inches long. The top 3 inches of each bar was cut off in the foundry, to ensure the removal of any piped material. Four bars were cast from each melt, two sand and two chill. The weight of the metal molds in which the chill cast bars were made was 26 pounds and the wall was about ⅝ inch thick at the top, increasing to 1⅛ inches at the bottom, and about 1¼ inches thick in the actual base. These molds were, as usual, heated before casting in order to get rid of moisture and to avoid unsoundness. They were coated on the inside with boiled linseed oil. The sand castings were in green sand.

The details of the different proportions of lead actually obtained in the eight different melts, and the temperature at which the bars were cast, are shown in Table III.

The casting temperatures recorded were those of the metal in the shank ladle before pouring into the molds, and were determined by means of a pyrometer having a nickel-chromium, nickel thermocouple, reading to a little above 1350 degrees Cent. The accuracy of the instrument was checked each time it was used against both a Fery radiation pyrometer and a pyrometer with a platinum, platinum-iridium thermocouple, no variation greater than 10 degrees Cent. being recorded at the temperatures at which it was operating.

The way in which each bar was cut up for examination is shown in Fig. 1.

The complete analyses of all the eight alloys, four from melts and four from remelts, are detailed in Table V.

The respective compositions are shown not to have been seriously altered in remelting. The usual reduction in the proportion of zinc and rise in that of the copper took place.

The figures in Table IV were obtained for this series of tests.

The results as a whole are plotted as graphs in Figs 2 and 3 compared with the minimum figure laid down by the admiralty specification for this material, viz. an ultimate stress of not less than 31,400 pounds per square inch, with a minimum elongation of 7.5 per cent on 2 inches.

Strength Increased

Taking first the results from the sand cast material, it may be seen that lead up to about 1.5 per cent progressively increases both the strength and the ductility of the alloys, while above 1.5 per cent both figures show some falling away. The tendency is shown equally well in both melts and remelts. As compared with the results from the melts, the remelted alloys show an improvement in both strength and ductility. It may be noticed that as the ductility increases the Shore and Brinell hardness figures fall away, so as to show a minimum figure at 1.46 per cent of lead, the point of maximum ductility. The results, which are thus consistent, are quite different from those of the previous workers, already referred to.

As has been previously noted when investigating the effect of antimony and arsenic, these effects of lead are somewhat masked in the chill castings. Thus, while the hardness figures of the chill castings are correlated quite well with those of the sand castings, the effect of lead, seen in the latter, of increasing the strength and ductlity up to 1.5 per cent is not shown, although there are indications of a turning point in the ultimate stress curve with this proportion of lead, but associated with a minimum rather than a maximum figure. The ductility, again, appears to show a progressive falling away as the lead increases, the lowest figures of all obtained with the maximum proportion of lead. These results are thus nearer to those of Primrose already quoted.

From the viewpoint of strength and ductility, there thus appears, in the case of sand castings, no justification for the limiting in the admiralty specification of the lead content of this alloy to 0.5 per cent. Up to 1.5 per cent might be allowed. This would result in improved mechanical qualities. However, as will be seen later, there are other considerations, to which due weight must be attached.

No differences in this respect were observable in the case of either the sand or chill cast bars containing the various proportions of lead, all of which were perfectly sound.

Shore and Brinell hardness determinations were made on pieces cut from the same corresponding positions at the top of each bar, as shown in Fig. 1. The plane surfaces on which the tests were made were finished by No. 1 emery-

Table I

Johnson's Tests on Chill-Cast Gun Metal

	Analysis				Alloys as Cast (Chill)					Alloys Annealed			
Marks	Copper, Per cent	Tin, Per cent	Zinc, Per cent	Lead, Per cent	Yield point, Lbs. per sq. in.	Ultimate strength, Lbs. per sq. in.	Elongation Per cent	Brinell hardness	Remarks	Yield point, Lbs. per sq. in.	Ultimate strength, Lbs. per sq. in.	Elongation, Per cent	Brinell hardness
S	88.0	9.85	2.15	nil	26,210	51,860	19.0	..	....	....	....	..	..
J	86.98	10.8	1.22	1.0	27,440	49,500	21.9	80	Metal fluid	....	....	..	..
SR	88.0	10.0	2.0	nil	34,500	52,190	10.0	89	....	22,510	57,340	66	..
Jr	86.88	10.08	1.98	1.06	28,740	49,060	12.0	86	....	22,850	51,980	53	70

The way in which each bar was cut up for examination is shown in Fig. 1.

The complete analyses of all the eight alloys, four from melts and four from remelts, are detailed in Table V.

The respective compositions are shown not to have been seriously altered in remelting. The usual reduction in the proportion of zinc and rise in that of the copper took place.

The figures in Table IV were obtained for this series of tests.

The results as a whole are plotted as graphs in Figs 2 and 3 compared with the minimum figure laid down by the admiralty specification for this material, viz. an ultimate stress of not less than 31,400 pounds per square inch, with a minimum elongation of 7.5 per cent on 2 inches.

Strength Increased

Taking first the results from the sand cast material, it may be seen that lead up to about 1.5 per cent progressively increases both the strength and the ductility of the alloys, while above 1.5 per cent both figures show some falling away. The tendency is shown equally well in both melts and remelts. As compared with the results from the melts, the remelted alloys show an improvement in both strength and ductility. It may be noticed that as the ductility increases the Shore and Brinell hardness figures fall away, so as to show a minimum figure at 1.46 per cent of lead, the point of maximum ductlity. The results, which are thus consistent, are quite different from those of the previous workers, already referred to.

As has been previously noted when investigating the effect of antimony and arsenic, these effects of lead are somewhat masked in the chill castings. Thus, while the hardness figures of the chill castings are correlated quite well with those of the sand castings, the effect of lead, seen in the latter, of increasing the strength and ductlity up to 1.5 per cent is not shown, although there are indications of a turning point in the ultimate stress curve with this proportion of lead, but associated with a minimum rather than a maximum figure. The ductility, again, appears to show a progressive falling away as the lead increases, the lowest figures of all obtained with the maximum proportion of lead. These results are thus nearer to those of Primrose already quoted.

From the viewpoint of strength and ductility, there thus appears, in the case of sand castings, no justification for the limiting in the admiralty specification of the lead content of this alloy to 0.5 per cent. Up to 1.5 per cent might be allowed. This would result in improved mechanical qualities. However, as will be seen later, there are other considerations, to which due weight must be attached.

No differences in this respect were observable in the case of either the sand or chill cast bars containing the various proportions of lead, all of which were perfectly sound.

Shore and Brinell hardness determinations were made on pieces cut from the same corresponding positions at the top of each bar, as shown in Fig. 1. The plane surfaces on which the tests were made were finished by No. 1 emery-

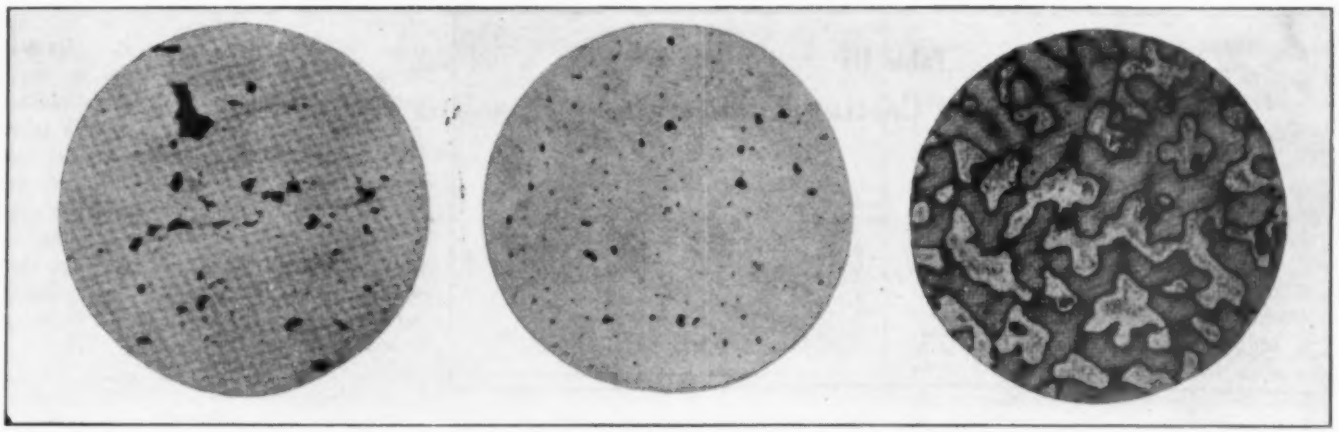


FIG. 4—FROM BAR A4S—SAND CAST—1.63 PER CENT LEAD—UNETCHED

FIG. 5—FROM BAR A4C—CHILL CAST—1.68 PER CENT LEAD—UNETCHED

FIG. 6—FROM BAR A1S—SAND CAST—0.17 PER CENT LEAD—ETCHED WITH AMMONIUM PERSULPHATE

paper. All Shore figures are a mean of seven determinations, and all Brinell figures a mean of three, with a pressure of 500 kilos. The results obtained are shown in Table IV, and Figs. 2 and 3. The effect of lead is the same in both sand and chill castings, gradually reducing the hardness up to about 1.5 per cent and increasing it again afterwards, this being, as previously stated, in the case of sand castings, correlated with the ductility.

The effect of lead on the microstructure has been discussed by previous workers. It is, for example, well known that in admiralty gun metal, phosphor bronze, plastic bronze, and similar alloys, practically all the lead separates out when the metal is solid, and can be readily observed in a polished specimen, that has not been etched, as a number of dark and more or less rounded inclusions scattered irregularly through the matrix. Further, as has been already stated by Law,* these lead inclusions are frequently "torn out in the process of polishing, leaving pits which appear as black dots in the photograph." This is well illustrated by Law's figure. The question has also been dealt with by Gilligan and Curran.†

On account of this separation of the lead, it is possible by a planimetric determination, by making due allowance for the specific gravity of the lead, to estimate approximately the proportion of this impurity present in a particular alloy. This, of course, varies in different parts of the same casting, owing to segregation of the lead. For example, in the 1.68 per cent sand cast alloy, the author found, by this method, proportions of lead varying between 1.08 and 3.26 per cent, the average figure approximating to that returned by analysis, viz. 1.68 per cent.

These small particles of lead are associated with and set in the eutectoid. The result of this is that, since in a chill-cast gun metal the eutectoid parti-

Table II

Analyses of Component Metals

	Rio Tinto Copper, Per cent	"Lamb and Flag" Tin, Per cent	Quirk, Barton & Burns' Lead, Per cent	Suzuki & Co.'s Zinc, Per cent
Arsenic	0.46	0.19	...	nil
Antimony	nil	0.10	0.08	nil
Tin	traces	99.30	0.14	nil
Lead	0.18	0.07	99.63	0.088
Iron	traces	0.03	0.10	0.014
Bismuth	nil	nil	...	...
Sulphur	nil	...	...	...
Nickel	nil	0.008	nil	nil
Zinc	nil	traces	traces	99.891
Silver	traces	nil	traces	...
Oxygen, etc. (diff.)	0.07	...	...	...
Copper	99.29	0.140	0.05	traces
	100.00	99.838	100.00	99.993

*"Alloys and their Industrial Applications," 2nd ed., 1914, p. 251, and Fig. 19 (at end of book).

†"Distinguishing Lead in Brass and Bronze," *The Metal Industry*, vol. xvi June 25, 1920, p. 511, Figs. 7, 8.

FIG. 7—FROM BAR A4S—SAND CAST—1.68 PER CENT LEAD—ETCHED WITH AMMONIUM PERSULPHATE

FIG. 8—FROM BAR A1C—CHILL CAST—0.17 PER CENT LEAD—ETCHED WITH AMMONIUM PERSULPHATE

FIG. 9—FROM BAR A4C—CHILL CAST—1.68 PER CENT LEAD—ETCHED WITH AMMONIUM PERSULPHATE

Table III

Lead Content and Casting Temperatures

Melt				Remelt			
Lead content per cent	Mark	Description	Casting temperature Deg. C.	Lead content per cent	Mark	Description	Casting temperature Deg. C.
0.17	A1C1 & 2	Chill	1210	0.18	B1C1 & 2	Chill	1220
0.17	A1S1 & 2	Sand	1210	0.18	B1S1 & 2	Sand	1220
0.86	A2C1 & 2	Chill	1220	0.91	B2C1 & 2	Chill	1210
0.86	A2S1 & 2	Sand	1220	0.91	B2S1 & 2	Sand	1210
1.46	A3C1 & 2	Chill	1220	1.48	B3C1 & 2	Chill	1210
1.46	A3S1 & 2	Sand	1220	1.48	B3S1 & 2	Sand	1210
1.68	A4C1 & 2	Chill	1200	1.67	B4C1 & 2	Chill	1230
1.68	A4S1 & 2	Sand	1200	1.67	B4S1 & 2	Sand	1230

cles are much smaller and more evenly distributed than under the conditions of slower cooling obtaining with sand-cast metal, so in the chill-cast alloy are these particles smaller and more evenly distributed than in the other case.

This is illustrated in Figs. 4 and 5. The former shows, at a magnification of 100 diameters, a plain polished section of *A4S*, the alloy containing 1.68 per cent of lead, sand cast. The same alloy, chill cast, and photographed under the same conditions, is given as Fig. 5. In the latter case the lead segregates are smaller and more evenly distributed through the matrix. The other alloys show the same features, but with the lesser proportions of lead.

Etching Developes Structures

The normal structure of gun metal is best developed by etching with a saturated solution of ammonium persulphate. Fig. 6 shows the microstructure of *A1S*, the sand-cast alloy containing 0.17 per cent of lead, and Fig. 7 that of *A4S*, the 1.68 per cent lead alloy, both at a magnification of 100 diameters. These show in each case the light matrix of primary *a*, the areas of secondary *a* as isolated and as ramified areas separated from the primary *a* by well-marked boundaries, while the eutectoid and lead areas are inset in the secondary *a*, the former, when free from lead, appearing as the usual speckled constituent, with angular outlines. They also indicate that the lead segregations, or more frequently the cavities left therefrom are dark, rounded and somewhat featureless.

Fig. 8 shows the microstructure of *A1C*, the chill-cast alloy containing 0.17 per cent of lead, and Fig. 9 that of *A4C*, the 1.68 per cent lead alloy, at the same magnification as before. The structure of chill-cast gun metal is not well resolved at this magnification, and as the lead segregations are smaller and much more dispersed, they are much less noticeable than in the case of the sand-cast alloy containing the same proportion of this impurity. The lead may, however, be readily observed on the polished specimen, as has been illustrated.

The chief adverse effect of lead in gun metal is that owing to the long cooling range of 200 degrees Cent. (during which the lead is of course molten, and is, as regards practically the whole of the lead present, merely mechanically contained in the alloy) there is an increased tendency towards segregation of the α-δ eutectoid. Ramsey mentions* the extrusion from a heavy casting, containing an average proportion of 0.5 per cent lead, of a brittle white constituent containing 6.5 per cent lead, and goes on to say, "The extraordinary concentration of the lead was suggestive. It would almost appear as if the tin and lead had combined to form low melting-point alloy which had sweated out. It might explain the objection to lead in gunmetal."

Lead Improves Machinability

There are one or two other points to consider. One is that of the machinability of the alloy, which it is almost superfluous to say is much improved by the addition of lead. Also it is suggested that we have no data to show that the resistance to corrosion might not be increased by the addition of 1 per cent of lead.

Compare the 2 per cent lead brass for which, when used as condenser tubes, a considerably increased resistance to the attack of sea-water is claimed than in the case of plain 70:30 brass.

In the case of gunmetal used for bearings, the increase in the lead would be advantageous. Thus it has been demonstrated by Charpy, by means of compression tests, that in the case of copper-tin-lead-zinc alloys, the addition of lead

*Journal of the Institute of Metals, No. 2, 1918, vol. xx. p. 186.

Table V

Analyses of Lead Alloys

Proportion of lead	0.17 per cent		0.86 per cent		1.46 per cent		1.68 per cent	
	Melt	Remelt	Melt	Remelt	Melt	Remelt	Melt	Remelt
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Copper	87.72	88.23	87.30	87.84	86.58	87.39	86.23	86.27
Tin	9.97	10.04	10.05	10.00	10.04	9.95	10.12	10.17
Antimony	trace	trace	trace	trace	trace	trace	trace	trace
Arsenic	0.48	0.47	0.50	0.47	0.48	0.48	0.47	0.49
Iron	0.08	0.05	0.07	0.04	0.06	0.05	0.06	0.06
Lead	0.17	0.18	0.86	0.91	1.46	1.48	1.68	1.67
Zinc	1.54	0.98	1.16	0.72	1.33	0.62	1.42	1.30
Nickel	trace	trace	trace	trace	trace	trace	trace	trace
	99.96	99.95	99.94	99.98	99.95	99.97	99.98	99.96

Table IV

Mechanical Test Results of Lead Alloy

				Sand-Cast Bars						Chill-Cast Bars					
Lead, per cent	Melt or Remelt	Casting temperature degrees C	Marks on test pieces	Yield point, lbs. per sq. in.	Ultimate strength, lbs. per sq. in.	Elongation, per cent	Stanton test impacts to fracture	Hardness Shore	Hardness Brinell	Yield point lbs. per sq. in.	Ultimate strength, lbs. per sq. in.	Elongation per cent	Stanton test impacts to fracture	Hardness Shore	Hardness Brinell
0.17	Melt	1210	A1S & C	23,300	33,150	11.5	191	8.5	74	23,740	38,300	5.0	30	9.0	91.0
0.86	Melt	1220	A2S & C	21,590	35,170	12.5	217	7.0	70	25,630	35,170	4.5	17	8.0	87.6
1.46	Melt	1220	A3S & C	21,950	35,620	15.0	103	6.0	66	22,800	32,030	3.5	31	7.0	82.6
1.68	Melt	1200	A4S & C	21,060	35,500	10.5	59	7.0	69	24,420	32,030	2.5	25	7.5	89.0
0.18	Remelt	1220	B1S & C	19,530	38,080	15.0	107	8.5	74	24,960	35,170	5.0	67	9.0	91.0
0.91	Remelt	1210	B2S & C	22,580	39,200	16.5	156	7.5	71	23,740	35,620	5.5	33	8.0	91.0
1.48	Remelt	1210	B3S & C	20,700	39,200	19.5	127	7.0	69	21,860	30,140	3.5	23	7.0	85.0
1.67	Remelt	1230	B4S & C	18,320	36,290	13.5	104	8.0	69	21,410	33,150	3.0	19	8.0	89.0

Table VI

Physical Tests of Different Gun Metals

Composition of Gun Metals			Hardness			Tensile Tests,		
Copper, per cent	Tin, per cent	Zinc, per cent	Melt or Remelt	Shore (Magnifier hammer)	Brinell	Yield point, lbs. per sq. in.	Ultimate strength, lbs. per sq. in.	Elongation, per cent
88	10	2	Melt	16	77	23,300	38,080	14.0
88	10	2	Remelt	14	79	20,380	38,080	17.2
87	8	5	Melt	18	80	18,590	37,630	18.7
87	8	5	Remelt	19	83	18,590	34,720	15.6
85	5	10	Melt	15	69	17,470	35,840	25.0
85	5	10	Remelt	15	69	17,250	34,720	23.4

increases the plasticity of the bronze; while with the similar alloys W. K. Frank found that the addition of lead gave rise to decreased wear as compared with the free alloys. It would appear strange that the presence in a bronze of a number of small particles of a soft and plastic metal having a higher coefficient of friction should lead to decreased wear in a bearing made from the alloy, which decreased wear could presumably only result from decreased friction. However, such appears to be the case.

There thus appears to be good reason for increasing the permissible limit of lead in sand-cast admiralty gunmetal from 0.5 to 1 per cent. It is clear that the supposed prejudicial effects of lead in gunmetal have, anyhow, been somewhat exaggerated.

Increases Strength

From the foregoing it may be concluded that in sand-cast admiralty gunmetal, the addition of lead up to a certain proportion progressively increases the strength and ductility and decreases the hardness. At a point corresponding to the presence of about 1.5 per cent lead, the strength and ductility begin to fall away and the hardness increases. Maximum resistance to repeated impact is obtained from the alloy containing about 1 per cent lead, larger quantities causing a progressive falling away in this respect. There is no apparent effect on the soundness of sand-cast gunmetal containing up to 1.68 per cent of lead. Lead is readily detectable in the microstructure.

In chill-cast gunmetal these effects are somewhat masked. The effect of increasing lead on the hardness is well correlated with that of the sand-cast material, with a change point at about 1.5 per cent lead, but associated with a minimum rather than a maximum strength figure. The ductility shows a progressive falling away as the proportion of lead increases. The same remark applies to the impact figure in the case of the metal melted twice, the results from the metal melted once being much more irregular. There is no apparent effect on the soundness of chill-cast gunmetal containing up to 1.68 per cent of lead. Lead is not so readily observable in the etched material, but can be quite well detected on the plain polished surface.

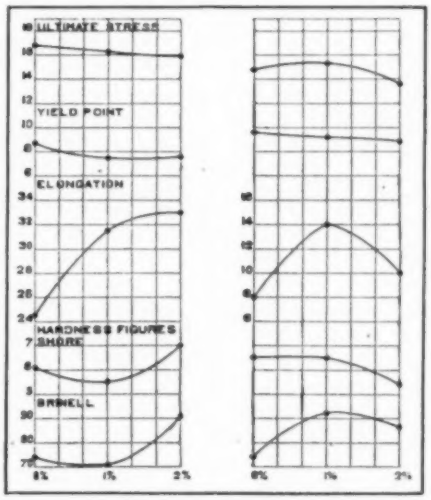


FIG. 10—SAND CAST FIG. 11—CHILL CAST

In view of the somewhat unlooked-for results obtained from the 88:10:2 alloy, it was considered that it would be of interest to extend the investigation on the effect of lead to another zinc-tin-copper alloy in common use. For certain purposes the admiralty alloy must naturally be used, for example, for bearings, for discs for high-lift pumps, and for similar purposes where hardness is essential. On the other hand, for general castings where special hardness is not requisite, and where the admiralty specification has not to be complied with, cheaper mixtures, obtained by decreasing the proportion of tin and increasing that of zinc, may often be substituted with advantage. The result is a progressive slight decrease in the yield point and maximum stress figures, accompanied by an increase in ductility, due to the decrease in the proportion of the hard and brittle δ constituent.

The effect of increasing the proportion of lead in the case of the last alloy was studied by making sand and chill castings of the normal alloy, and also by adding respectively 1 per cent and 2 per cent of lead in addition. The conditions were otherwise similar to those already described in the case of the 88:10:2 alloy, while the casting temperatures were all in the region of 1200 degrees Cent. The results of mechanical tests of 85:5:10 gunmetal containing varying proportions of lead are shown in Table VII.

Mechanical Results Plotted

The mechanical test results are plotted in Figs. 10 and 11. It may be seen that in sand castings of this alloy increasing lead causes a slight falling away in the yield point and ultimate stress figures, with a corresponding increase in softness and ductility. The results from the chill castings are, as usual, more erratic, but show on the whole the same general tendencies.

As in the case of the 88:10:2 gunmetal, both sand and chill cast, the hardness figures of the sand cast 85:5:10 alloy show a minimum, in this instance at a figure of 1 per cent lead, after which there is an increase in the hardness. However, the present alloy when chill cast, tends to show the reverse, a maximum hardness at the point in question.

No differences in soundness could be observed in the case of the three alloys either when chill cast or when sand cast.

The microstructure of the 85:5:10 alloys differs from that of admiralty gunmetal in that the eutectoid has all disappeared, the alloy being now composed entirely of *a*. The lead is still observable as separate segregations, or as cavi-

Table VII

Effect of Varying Amounts of Lead on Gun Metal

	Sand-cast bars					Chill-cast bars				
Lead, per cent.	Yield point, lbs. per sq. in.	Ultimate strength, lbs. per sq. in.	Elongation, per cent	Hardness Shore	Brinell	Yield point, lbs. per sq. in.	Ultimate strength, lbs. per sq. in.	Elongation, per cent	Hardness Shore	Brinell
0	19,490	37,630	24.5	6.1	74	21,500	33,350	8.0	6.5	74.0
1	16,800	36,512	31.5	5.5	71	20,610	34,270	14.9	6.5	92.0
2	17,020	35,620	33.0	7.0	91	19,940	30,460	10.0	5.4	86.5

ties resulting from the tearing out of the same.

Taking the two investigations as a whole, one of the outstanding features is the fact that, up to a certain proportion, the addition of lead to zinc-tin-copper alloys considerably increases the ductility. This is referred to more than forty years ago by Boyd Dawkins, who remarks, regarding the ancient bronzes, "Lead would increase the toughness of the alloy." The work now put on record affords an interesting confirmation of the correctness of this view, which would also appear to be in accordance with those of some of the other experimenters whose work has been referred to in this article.

Hints on How To Make Home Made Tools

BY M. E. DUGGAN

SOME time or other in his career every patternmaker has tried his hand at making one or more of the so-called *home made* tools. Most of the time and labor expended in this kind of work is wasted, particularly when his efforts have been directed toward the production of edged tools. He is not satisfied with making the part of the tool he understands, that is the part of the tool made out of wood; he insists on making the cutting tool of steel.

A short time ago there appeared in THE FOUNDRY an article by the writer illustrating how a set of round bottom planes was altered to meet the requirements of the patternmaker. One of the things I was particularly careful about was redesigning the existing plane without altering the cutting metal, excepting to cut a part off the upper end.

A patternmaker having read the article in THE FOUNDRY thought the idea a good one and undertook the job of making a set of these planes for his own use. I met him some time afterward and he told me that he had changed a few planes according to my suggestion but they were not a success. I learned later that he had made a new set of cutting tools and having tempered them himself had spoiled them. No matter how artistically a tool may be designed or constructed it is of no use if the cutting part will not cut.

I do not state that every home-made tool is useless or that all the time spent on their construction is wasted. However, this I will say that the pattern maker who only has a hazy idea of tempering and who attempts to make edge tools, *is wasting* his time.

I have a set of four chisels from ½ inch to 1½ inches made from files and I also have a nice and handy set of turning tools made from a number of old files. It is not necessary to draw the temper before attempting to grind away the teeth on a file. In general, when a patternmaker selects a discarded file he will pick out a large, coarse-cut specimen. Then he will have some friend in the smith shop draw the temper, after which he will take it to the pattern shop and grind it on a stone which turns about 15 revolutions a minute. He will spend hours at this work, grinding away the teeth, finishing and polishing it and then spoil the whole job by attempting to harden and draw the temper himself; or have his friend—who knows nothing about edge tools—do the job for him.

I made a perfectly good 1-inch chisel from an old file in the following manner: I selected for this chisel an 8-inch hand file, dead smooth cut, perfectly flat on one side, or as nearly flat as it is possible to get it. I ground away the teeth on an emery wheel.

I finished grinding the tool on a worn grindstone. A coarse cutting stone will leave grooves in the back or flat face of the chisel. The cutting edge was finished with a fine flat emery stone by hand. The temper was drawn to a dark straw color over an alcohol lamp. The heat should always be started at the tang end and never at the cutting end of the tool. I never attempt to draw more than one inch of the cutting edge. The temper should be drawn before grinding the bevel. If it is attempted afterward the thin edge may be burned.

Pattern and Corebox Made from Casting

BY M. E. DUGGAN

A FOUNDRY secured an order for making 100 T-pipes similar to the one shown in the accompanying illustration. The customer was not concerned over the style or type of pattern employed so long as the castings met his specifications. The foundry company had to supply its own pattern and since the tender on the job had to meet competitive bids from out of town foundries specializing in that class of work it was essential that the patternmaking expense be held to a minimum. Another feature which influenced the management to submit a low bid with a corresponding narrow margin of profit was that orders were not any too plentiful and the job promised to furnish employment for several men for some time.

The problem the foundryman had to solve was whether it would be cheaper to get a regular pattern and corebox made at a jobbing shop at an estimated cost of $75 or to fit up an existing casting as a pattern and lose a certain amount of time on the making of each mold. The foundryman decided to adopt the latter alternative and to this end borrowed a casting from the customer and fitted wooden core prints in the ends as shown at *B* and *D*. The print marked *C* is shown different from the others to illustrate a second method, as is explained later.

Owing to the shape of the pattern no particular difficulty was anticipated either in securing a lift in the cope or in drawing the pattern out of the drag. As may be noted at *B* and *D* the prints are made flush with the outside diameter of the pipe. This method is preferable to that usually adopted by the regular patternmaker and illustrated at *C*. In this case all three prints were made alike to the large diameter. A moment's reflection will show that where the shoulder is formed on the core there is no danger either of a crush or a mis-match on the joint line. Even if the flask shows a shift due to ill fitting guides the shift will not affect the inside of the pipe.

To make a corebox for this job the casting was set into a follow board up to the center, or parting line. A drag then was set on, filled with sand, rammed and rolled over. The casting was taken out and the half mold then was filled with core sand, rammed, swept off flush, turned over on an iron core plate and run into the oven. After it had dried it was taken out and the surrounding black sand removed leaving a perfect replica of the half pattern with the core

prints attached. The prints were not touched but a thickness of sand was rubbed off the remainder of the core all over to correspond to the thickness of metal in the casting.

After the core had been filed down to the desired size it was laid on an iron plate where it was surrounded by a fairly close fitting wooden frame. Reinforcing rods were placed at various points and then the frame was filled with plaster of paris. After the plaster had set a wooden back was nailed to the frame, the whole thing was turned over and the half core removed leaving a perfectly smooth half corebox. The casting was symmetrical and therefore the top and bottom half cores could be made in the one corebox.

Making the mold involved no unusual features with the possible exception that instead of using a half pattern on a plain, flat board, the cast-iron pattern under consideration was laid half way into a follow board each time the drag was rammed. A ½-inch hole drilled and tapped about 4 inches from each of the three ends and a fourth hole in the center, all on the cope side, were engaged by suitable lifting screws for drawing the pattern. When the crane was available the screw was inserted in the hole in the middle. At other times two men were employed. One man lifted on two of the screws while the second man lifted with one hand and steadied the pattern with the other. The castings weighed 250 pounds each.

Small Chilled Roll Molds Cause Explosion

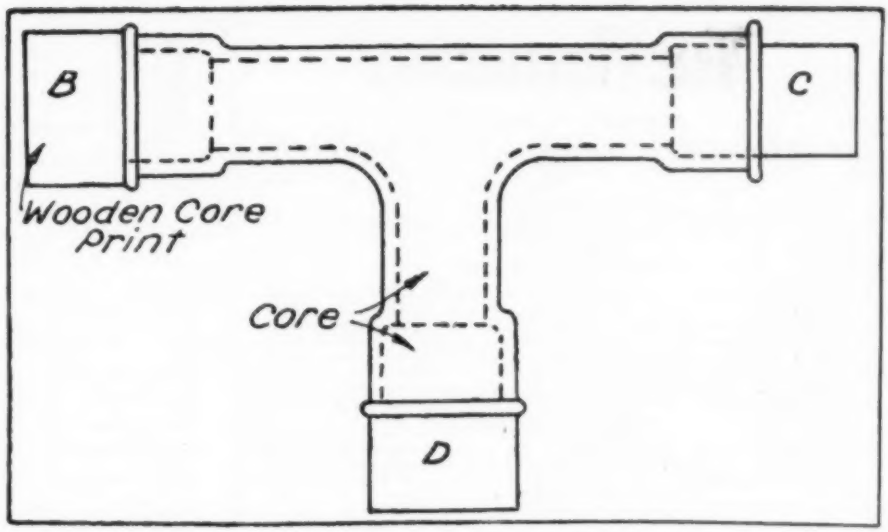
By Pat Dwyer

Question: We are enclosing a sketch of a hollow cast iron roll which has been causing us considerable trouble. These rolls are made of different diameters from 6 to 8 inches and of varying lengths from 18 to 40 inches. The thickness of the shell is ⅜-inch. We are casting them vertically and we heat the chills before using them. When we are nearly through pouring the mold an explosion occurs and the iron is thrown out in large quantities making it exceedingly dangerous for the workmen in the vicinity, to stand near them. We also notice that the iron solidifies too rapidly resulting in the rolls being imperfect on the end.

Answer: From what you say about the molds exploding while pouring your chilled rolls we are of the opinion that the vent from the core is not getting away freely. You say that the chills are heated before using so we infer that similar precautions are taken with the steel shaft which goes in the center. As a further precaution the parts of the shaft which are exposed to the molten iron in the three hubs should be made clean and bright and covered with a thin coating of oil.

We presume that the core is made in a half box and afterward the two halves pasted together. We should advise that two holes be bored in each end of the box as shown in the accompanying illustration. Run a half inch rod from end to end of the box in these holes before putting in any sand. When the core is rammed and the corebox has been turned over on the plate the rods may be pulled out and the box lifted off. These holes will provide a clear vent for the core and should be connected to suitable openings in the cover plate.

Your method of gating as shown in the sketch submitted is not conducive to favorable results. We should pour these castings from four 1 x ¼-inch pop gates equally spaced on the top rim.



C ILLUSTRATES A WAY TO MAKE A CORE PRINT DIFFERING FROM THAT SHOWN AT B AND D

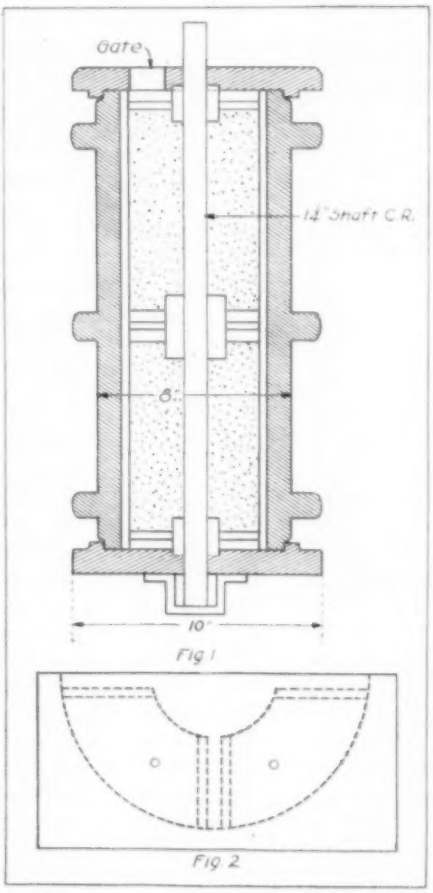


FIG. 1—SHOWING SECTION OF MOLD WITH CORE AND STEM SHAFT IN POSITION FIG. 2—END OF CORE-BOX SHOWING HOLES FOR VENT RODS

Organize a New Powdered Fuel Corporation

The Powdered Coal Development Corp., has been organized with headquarters in Omaha, Neb. This company controls the Pruden patents in the western portion of the United States, and will engage in financing and erecting central plants and will install equipment for burning pulverized coal. Byron H. Oberst, formerly with the Interstate Oil & Refining Co., is president of the new corporation. The board of directors includes R. M. Robertson, construction engineer, American Smelting & Refining Co.; A. E. Hall, manager, Omaha plant, American Smelting & Refining Co.; Joseph Weeth, president Harmon Weeth Coal Co.; J. J. Dodds, president of the Dodds Lumber Co.; Bert Phillips, formerly chief engineer, Omaha plant, Collis Products Co.; and Irving H. Arey with the Republic Metal Ware Co.

The total production of coal in France in 1920 was 25,276,304 tons, as against 22,476,776 tons in 1919, Lorraine production included in both cases. There was, therefore, an increased production of 2,797,538 tons.

THE FOUNDRY

Registered U. S. Patent Office

A semimonthly journal devoted to all branches of the foundry trade

Published by
THE PENTON PUBLISHING CO., CLEVELAND

BRANCH OFFICES

BOSTON.....476 Old South Bldg.
CHICAGO.....1147 People's Gas Bldg.
CINCINNATI.....501-505 Commercial Tribune Bldg.
HARTFORD.....P. O. Box 1231
NEW YORK.....2203-2206 St. Paul Bldg.
PITTSBURGH.....2148-49 Oliver Bldg.
SAN FRANCISCO.....8 Monadnock Block
WASHINGTON, D. C.....40 Metzerott Bldg.

FOREIGN OFFICES

BIRMINGHAM, ENGLAND.....Prince's Chambers
LONDON, ENGLAND.2-3 Caxton House, Westminster, S.W. 1
PARIS FRANCE.....224 Rue de Rivoli
Cable address, IROTRAPEN, London

SUBSCRIPTION

United States and Mexico.....$3.00 a year
Canada.....$4.00 a year
Great Britain and other Foreign Countries.....$5.00 a year
Single Copies.....25 cents
Copies published three months or more previous to date of current issue, 50 cents each

ADVERTISING

All communications relating to advertising copy, discontinuances, etc., must be received on the 1st and 15th of the month preceding date of publication.

Member, the Audit Bureau of Circulations and Associated Business Papers Incorporated

Entered at the Post Office at Cleveland as Second Class Matter

Copyright 1921 by The Penton Publishing Co.

Contents

	Page
Making Water Turbine Castings—I	873
Moves Toronto Office	878
Changes Firm Name	878
How a British Foundry Specializes	879
Prophesies Electric Smelting Iron Ores	887
Welding Outfit Finds Many Applications	888
Book Review	889
Causes for Blowholes	889
Melting Copper in Cupola	889
Iron Ore in Montana	889
Bill Makes a Loam Mold for a Cast Iron Pot	890
Electric Furnaces for Gray Iron	893
Annealing Temperature for Gray Iron	895
Acquires Pulverized Fuel Engineering Interests	895
Mold Tractor Link with Green-Sand Core	896
Devise Bending Test for Malleable	897
Defective Castings to Take Scrap Freight Rate	898
Auto Vehicles Registered	898
Erects New Car Shops	898
How and Why in Brass Founding	899
Casting Large Manganese Bronze Bushings	899
Recovering Lead from Old Battery Plates	899
Hot Sand in Flasks Causes Porous Castings	900
Brass Defects Due to Included Dross	900
Causes of Spots on Brass Ornamental Castings	900
Flux for Aluminum Alloys	900
Study Effect of Lead on Gun Metal	901
Drawing Should be Plain and Explicit	905
Hints on How to Make Home Made Tools	906
Pattern and Corebox Made from Casting	906
Small Chilled Roll Molds Cause Explosion	907
Organize a New Powdered Fuel Operation	907
Apprentices Need Wider Training	908
Trade Outlook in the Foundry Industry	909
Personal	910
Ohio Foundrymen Hold Second Meeting	910
A. F. A. Announces Meeting in Cleveland	910
Obituary	911
Develops Trailer Truck for Severe Service	911
Device Introduces Flux Into Molten Metal	912
Pours Several Ladles of Metal at One Time	912
Solder for Aluminum	912
Quiet Rules in Equipment Market	913
What the Foundries Are Doing	914
New Trade Publications	914

Apprentices Need Wider Training

FOR purpose of comparison many foundry apprentices may be divided into three general classes; those who are physically lazy, those who are mentally lazy and those who are lazy both in body and mind. Judicious and well-applied supervision may develop the members of the first class and make them fairly competent workmen. Ambition which may be lying dormant and susceptible to a slight spur from an outside source may be the means of developing an apparently mentally lazy individual into a human dynamo. Those who are both physically and mentally lazy possibly fill a gap in the general scheme of industrial life for it always will be necessary to have hewers of wood and drawers of water.

Statistics compiled by the various examining and registration bureaus connected with the American expeditionary forces indicate that a majority of the young men who were examined for service overseas had an arrested mental development equivalent to that of a 12-year-old boy. Statistics compiled by the welfare and employment departments of some of the great industrial enterprises seem to bear out the same conclusion.

The antipathy evinced to all forms of learning by the boy who goes at a snail's pace to school is intensified as he increases in years and stature and gradually draws away from parental and scholastic control. Placed in a foundry to learn a trade, in company with men skilled in the performance of certain more or less routine work, a youthful and boyish spirit of emulation leads him to absorb as much of the knowledge of the trade as these men are capable of imparting. When he has progressed to a point where he is competent to turn out as much work in a day as the men with whom he associates, he feels that he has reached the summit of his career and there is no more to learn.

In the natural course of events and without any special effort on his own part, the old-time foundry apprentice had an opportunity to secure a comprehensive knowledge of the trade. The gradual evolution of the business, specialization, higher standards and the increased application of mechanical contrivances for handling the work, necessitate a vast amount of individual effort on the part of the modern young man who aspires to the position of a master craftsman. On the other hand, the opportunities for securing increased knowledge and the desirable positions awaiting the young man who is qualified to fill them never were so great as they are today.

The rule of thumb methods, the secret and mysterious processes jealously guarded, at one time regarded as part and parcel of the operations involved in the casting of metals, practically have disappeared. Through efforts of foundrymen's associations, correspondence courses and various forms of technical literature, the results attained by progressive foundrymen are placed at the disposal of all who wish to avail themselves of the knowledge.

In the foundry business, as in any other, there is no royal road to success and while the young man may be willing to work and study he is handicapped by a naturally limited viewpoint. The men in charge of casting plants with their wider experience should consider it as much of their duty to encourage the mental development of the young men in their charge as it is to develop their skill.

Trade Outlook in the Foundry Industry

ALTHOUGH no substantial reason can be assigned for improvement, a steady betterment is apparent in the castings industry. This condition is not confined to any one line, nor to any one section of the country; but the rate of advance is more strongly emphasized in some classes of manufacture. Radiator, stove and furnace, sanitary ware, cast-iron pipe, and municipal castings makers still continue in the forefront and demand which at first was deemed seasonal has continued uninterruptedly beyond the period normally assigned for activity. Building hardware, plumbing sundries and heating castings also have shown surprising strength.

Pipe Still Active

Bids recently submitted for 17,000 tons of cast-iron pipe at Detroit indicate that the character and volume of demand is strong. The lowest figure submitted was $34 a ton, Birmingham, while it was expected that the attractive size of the order would develop a low offer of $30. Diminishing inquiry for cast pipe finds the foundries unusually well provided with work on their books. Stove and furnace plants have experienced an unusual demand. Retail stocks of heating units have been allowed to dwindle and the tonnage of castings ready for assembly in the factories was permitted to reach a low figure. Consequently this division of the castings industry has maintained an exceptional schedule of operation and recent purchases of iron indicate continued faith in the next few months demand. Radiator plants, in general, are engaged practically to capacity, and a like condition prevails among the manufacturers of sanitary ware, due to extensive house building.

Prices of Raw Material for Foundry Use

CORRECTED TO NOV. 9

Iron		Scrap	
No. 2 Foundry, Valley	$22.50 to 24.50	Heavy melting steel, Valley	$14.25 to 14.75
No. 2 Southern, Birmingham	18.50 to 19.00	Heavy melting steel, Pitts.	14.50 to 15.00
No. 2 Foundry, Chicago	21.00 to 22.00	Heavy melting steel, Chicago	12.50 to 13.00
No. 2 Foundry, Philadelphia	21.85 to 23.25	Stove plate, Chicago	14.00 to 14.50
No. 2 Foundry, Buffalo	19.50 to 20.00	No. 1 cast, Chicago	15.50 to 16.00
Basic, Valley	19.00 to 19.25	No. 1 cast, Philadelphia	18.00 to 19.00
Basic, Buffalo	19.00 to 20.00	No. 1 cast, Birmingham	16.50 to 17.50
Malleable, Chicago	21.00	No. 1 cast, Buffalo	12.00 to 12.50
Malleable, Buffalo	20.50	Car wheels, iron, Pittsburgh	16.50 to 17.50
Coke		Car wheels, iron, Chicago	16.00 to 16.50
Connellsville foundry coke	$4.00 to 4.50	Railroad malleable, Chicago	14.50 to 15.00
Wise county foundry coke	5.75 to 6.00	Agricultural mal., Chicago	14.50 to 15.00
		Railroad malleable, Buffalo	12.00 to 13.00

Exceptions Are Noted

Some specialty makers do not share in the general improvement. No betterment is apparent in implement lines, some of the larger foundries devoted to this class of work being practically idle. The same condition prevails among builders of heavy machine tools and consequently low schedules of operation are observed among jobbing shops handling this class of work exclusively. Jobbing foundries share the fortunes of the different lines for which their castings are required. Those making manhole covers, gutter inlet and other municipal sundries are busy. A variation in demand obtains in gray iron, malleable and steel foundries alike. Automotive castings plants are practically idle, reflecting the slack conditions in the demand for trucks, tractors and passenger automobiles. By way of contrast, builders of small gas engines are active and foundries making this class of work are fairly busy. Balancing the exceptions noted against the foundries previously mentioned, the general average of operation shows improvement. A concrete instance of this is furnished by a recent survey made by the Ohio State Foundrymen's association. The average melt, compiled from answers to a questionnaire, shows 25 per cent for Nov. 1 as compared to 20 per cent Oct. 1 and probably 15 to 18 per cent for Sept. 1.

Iron Output Gains

Pig iron production in October showed a substantial gain. According to statistics compiled by *The Iron Trade Review*, the October total was 1,233,232 tons as compared to 985,795 for September. This marks a gain of 247,437 tons, while the daily average production has increased from 32,857 tons in September to 39,871 tons in October or practically 22 per cent. The total output of merchant iron for October was 204,803 tons, giving an increase of 47,075 tons over the September total of 157,728 tons. On an average daily basis, the merchant pig iron production was at the rate of 6606 tons, as compared with 5257 tons for the previous month, a gain of 1349 tons per day or 25.6 per cent. This gain in average production is yet more significant when compared with the July average output when the low point was passed. During July the average daily make of merchant iron throughout the country was 4633 tons. The gain of October over July is 1973 tons per day or 42.6 per cent. On Oct. 31, 95 stacks were in blast, giving a net gain of 11 over the total for Sept. 30. Six merchant furnaces were blown in and two blown out during October, giving an increase of four. Foundry pig iron stocks in general are sufficient for from two to four months under the reduced operating schedules prevailing. These obviously would shrink rapidly under full time work, and probably would not be sufficient for more than a few weeks. More interest is noted in pig iron for 1922 delivery. A Wisconsin machinery manufacturer has closed for 9000 tons of iron for first half delivery. The outlook for railway casting business continues to improve. During the past two weeks a number of important car inquiries have appeared. During October the purchase of over 15,000 cars was authorized while the September inquiries totaled 5790. Orders during October amounted to 8500 cars.

Nonferrous prices, based on New York quotations in the *Daily Metal Trade* for Nov. 9 follow: Casting copper, 12.37½c; electrolytic copper, 13.12½c to 13.25c; lead, 4.70c; Straits tin, 28.50c; antimony, 4.75c; aluminum, No. 12 alloy, open market, 14.00c to 16.00c. Zinc is 4.70c to 4.75c, E. St. Louis. The daily average prices of nonferrous metals for October follow:

OCTOBER AVERAGE PRICES

(New York Quotation)

Casting Copper	Electro. Copper	Lead	Tin Straits	Antimony	Aluminum 98.99	Zinc St. Louis
12.48	12.95	4.71	27.73	14.89	18.30	4.60

Personal

Herbert Field recently elected president of the Birmingham branch of the Institution of British Foundrymen has the distinction of being the youngest foundry president in Great Britain. Hints have already been given that he is the coming president of the Institution. By general agreement he is one of the most capable technical leaders of the British foundry trade. He was born in Birmingham in 1892, and received his metallurgical training at the Birmingham Municipal Technical school under the late H. A. Iorns, junior demonstrator. After valuable work in a number of laboratories at works in Birmingham and elsewhere he became metallurgist and chemist eight years ago for the firm of John Harper & Co., Ltd., Albion Works, Willenhall, South Staffordshire a well-known foundry and engineering concern. In that position he devoted his attention largely to foundry work, and particularly to light castings in gray iron, semisteel and malleable. At the beginning of his connection with the firm, he inaugurated a works laboratory of which he has since been in charge. His official progress in connection with the Institution of British Foundrymen has been rapid, since he became secretary in 1919, and after holding the post for two years has now become president.

Nils Anderson, of Debevoise-Anderson Co., 56 Liberty street, New York, sellers of coke, pig iron, etc., left recently for a trip to Europe to be gone about two months.

Harding Allen of Charles G. Allen & Co., Barre, Mass., iron founders, has been elected treasurer of the Worcester county farm bureau, headquarters of which are in Worcester, Mass.

Paul Ramp has been made superintendent of the Advance-Rumely Co., tractor manufacturer, Battle Creek, Mich. Mr. Ramp formerly was connected with the American Steam Pump Co. of that city.

J. E. Wilcox, formerly with the Saginaw Malleable Iron Co., Saginaw, Mich., has been made foundry superintendent for the United States Malleable Iron Co., Toledo.

H. D. Beard, who formerly was connected with the Davis Sewing Machine Co., Dayton, O., has accepted a position with H. Brewer & Co., Tecumseh, Mich., manufacturer of clay working machinery.

William W. Mills, for five years assistant chief chemist of the Pittsburgh Crucible Steel Co. at Midland, Pa., has been added to the faculty of the College of Wooster, O., as instructor of chemistry.

Charles H. Witters has been made manager of the Milwaukee branch of the E. J. Woodison Co., Detroit, succeeding his father, H. M. Witters, who has resigned to become sales manager of the Western Malleables Co., Beaver Dam, Wis.

Ohio Foundrymen Hold Second Meeting

The Ohio State Foundrymen's association organized early this year held its second meeting, in Cleveland, Nov. 7. This meeting was attended by a large percentage of the membership and was characterized by the free interchange of information on orders, inquiries, operating schedules and wages. The discussion was led by L. B. Weber, Elmwood Foundry Co., Cincinnati, president of the association. A chart was presented by the secretary, Samuel Powell Jr., Hamilton, O., showing the trend in the average melt, stocks of iron and pig iron purchased. The melt is shown to have dropped from 25 per cent during March and April to 15 per cent in May. Then a rise during the summer months was followed by a drop during August, and again during October, to be followed by a rise to about 25 per cent on the first of November. The stock curve shows a steady decline from 80 per cent in August with a slight hump in the curve which again descended on Nov. 1 to about 60 per cent. Pig iron purchased showed an increase from 5 to 10 per cent on the first of October, but has again dropped to the lower figure. These percentages are computed on the basis of the average tonnage melted by the foundries reporting.

In the detailed reports submitted by various members from throughout the state, agricultural, machine tool, automobile, heavy machinery and engine castings plants are shown to be closed or upon extremely reduced schedules. Plumbing, cast-iron pipe, stove and furnace castings manufacturers, on the contrary, are fairly active, some attaining as high as 80 per cent operation. A favorable sign is reported in the increasing business in patterns, some jobbing pattern shops being engaged practically to capacity.

The morning session was devoted largely to the discussion of a form of pig iron contract proposed by the National Association of Purchasing Agents. The points recommended by the Ohio Foundrymen will be interesting in the revised form to be presented to the producers and finally adopted by the purchasing agents. A suggestion was made that a clause be inserted to assure that the buyer receives pig iron of the analysis specified. In event of a dispute between the customer and the furnace relative to the analysis of iron delivered, the agreement will provide for submitting the question to a chemist or metallurgist of recognized standing, both parties to abide by the referee's decision. One of the most important features of the proposed contract is that which provides that the buyer shall have the privilege of cancelling any shortage of any month's deliveries due to the seller's failure to ship, when thirty (30) days overdue, by giving notice in writing of cancellation to the seller within ten (10) days after that time. The seller is given a like privilege of cancellation upon the failure of the buyer to receive delivery. In event that neither party cancels within the stipulated period, no concellation may be made and the amount of the shortage is to be delivered and received, the period of the contract being proportionately extended, unless otherwise agreed.

During the afternoon session, the members were addressed by A. O. Backert, vice president and general manager, Penton Publishing Co., Cleveland, and by W. H. Barr, president, National Founders Association, Buffalo. The association voted to hold its meetings quarterly in the future.

A.F.A. Announces Meeting in Cleveland

Cleveland has been selected as the place of the convention and exhibit of the American Foundrymen's association to be held during the week of April 24, 1922. The association headquarters and exhibits will be in the new Cleveland public hall, at Lakeside avenue and East Ninth street, which is rapidly nearing completion. The institute of Metals Division of the American Institute of Mining and Metallurgical Engineers has announced that it will hold a joint convention at the same time as has been their custom in years past.

Of the cities considered, Cleveland is most centrally located for the membership, for the foundry industry, and for the manufactures of foundry equipment and supplies who make annual exhibits, and its selection will conserve traveling and freight expense. The new public hall is only a few minutes' walk from the downtown hotels, and is directly across the street from the old Central armory

where the first foundry equipment exhibit was held in conjunction with the meeting in 1906.

Following an interval of 18 months the next meeting promises to be of unusual interest and profit. The papers committee reports that manuscript copies are being received and that the first set of preprints of papers to be presented at the convention will be mailed out in January.

Engineers Consider Waste

Discussion of elimination of waste in industry will comprise the most important feature of the meeting of the American Society of Mechanical Engineers, to be held in New York, Dec. 5 and 9. In fact, a national forum over which Secretary of Commerce Herbert M. Hoover will preside, will be devoted to this subject. Discussion will focus around the report on industrial waste recently completed by the American Engineering council of the Federated American engineering societies after an investigation of five months.

German Exhibits Excluded

The British foundry exhibition to be held in Birmingham has declined to admit German exhibitors. A short time ago the German ambassador to Great Britain made an application on behalf of the Verein-Deutscher Eisengiessereien whose headquarters are at Dusseldorf for permission to exhibit German products. The foundry industry in Germany is of a large and comprehensive character, and is understood to comprise as many as 2700 iron and steel foundries. The authorities in charge of the show have sought to make the exhibition thoroughly international, but after careful consideration they felt obliged to refuse the application. One of their difficulties arises from the fact that the space is nearly all taken, and if Germans were admitted, the committee might find itself obliged to refuse applicants from allied or neutral nations which would create an undesirable position, and this was made the main ground of refusal.

The policy of German exclusion was initiated by the Iron and Steel institute and several of the British learned and technical societies at an earlier date and the British Cast Iron Research association, which is taking the initiative in the foundry exhibition, naturally considered that it was scarcely their duty to take a lead in again recognizing German participation.

The winter meeting of the American Institute of Chemical Engineers will be held in Baltimore, Dec. 6-9. This will be the fourteenth annual meeting of the Institute.

Obituary

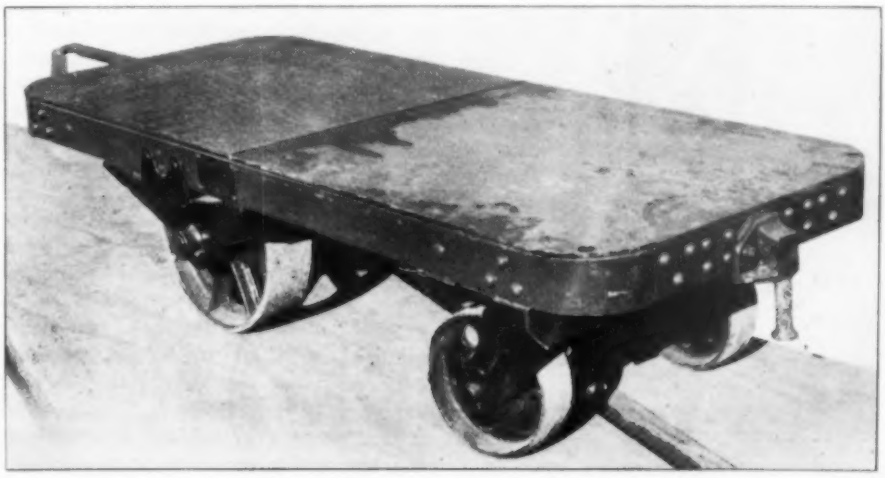
James Brown Rider, vice president and general manager of the Pressed Steel Car Co., Pittsburgh, and the Western Steel Car & Foundry Co., died Nov. 3 at his residence in that city after an illness of four months. On July 2, the day he was to sail for Cuba to attend to business matters in connection with his vice presidency of the American Steel Co. of Cuba, Mr. Rider was stricken with tumor on the brain in New York City and removed to a hospital. Three weeks later, Dr. Cushing, an eminent specialist, performed a delicate operation in Boston, removing the tumor. Mr. Rider was brought to his home on Aug. 28 but never fully recovered. Mr. Rider was born in Morrisons Cove, Blair county, Pa., on Sept. 10, 1879, and entered the service of the Pennsylvania railroad in 1895 as messenger boy. He worked through the several stages of shop order clerk, invoice clerk and stenographer, leaving the railroad in 1899 to become connected with the Pressed Steel Car Co. as stenographer and clerk to the general manager. In 1905 he was advanced to assistant to the vice president, and four years later was appointed general manager, just 10 years after his coming to the company as stenographer. In 1913 he was made a member of the board of directors and the same year appointed general manager of the Western Steel Car & Foundry Co.

John Wittman, president of the Atlas Brass Foundry Co., Columbus, O., died Oct. 17 at a rest home in Worthington, O., after failing health for the past two years, the last three months of which had been the most serious. Mr. Wittman was 65 years old.

T. W. Roberts, superintendent of the Radford plant of the Lynchburg Foundry Co., Lynchburg, Va., died at his home in Radford, Va., Oct. 8, after two weeks illness. Mr. Roberts was born in Albermarle county, Virginia, July 13, 1847. He entered the old Dabney foundry as an apprentice at 14 years of age, but his apprenticeship was interrupted by his enlistment in the Civil war, joining Company G, Armory Battalion, under Captain Sloat. He was later made corporal and sharpshooter. Six months after the war ended he went North where he stayed for about eight years and was connected with a number of foundries as molder in New York and New Jersey. He returned to his native state in 1873 and became connected with the Glamorgan Co., Lynchburgh, and later with the Norfolk & Western Railway Co., at Roanoke, Va. Realizing that the cast iron pipe industry held large possibilities in the South, Mr. Roberts entered this line of work and he was connected with it for many years until his death. He was one of the founders of the Lynchburg Foundry Co. He was the originator and inventor of a number of improvements in the foundry industry in which he always took a keen interest.

Develops Trailer Truck for Severe Service

To meet the demand for industrial trailers as a result of the increased use of industrial tractors, the Kilbourne & Jacobs Mfg. Co., Columbus, O., is manufacturing a trailer which has a rated capacity of 6000 pounds. One of these trailers provided with a steel plate platform is shown in the accompanying illustration. To obtain a highly mobile type of running gear, two load carrying wheels and two casters are used, the two wheels turning on individual axles set in cast steel yokes or brackets. Each caster swivels on a well lubricated loose steel ring set



TRAILER TRUCK CONSTRUCTED TO HANDLE HEAVY DUTY SERVICE

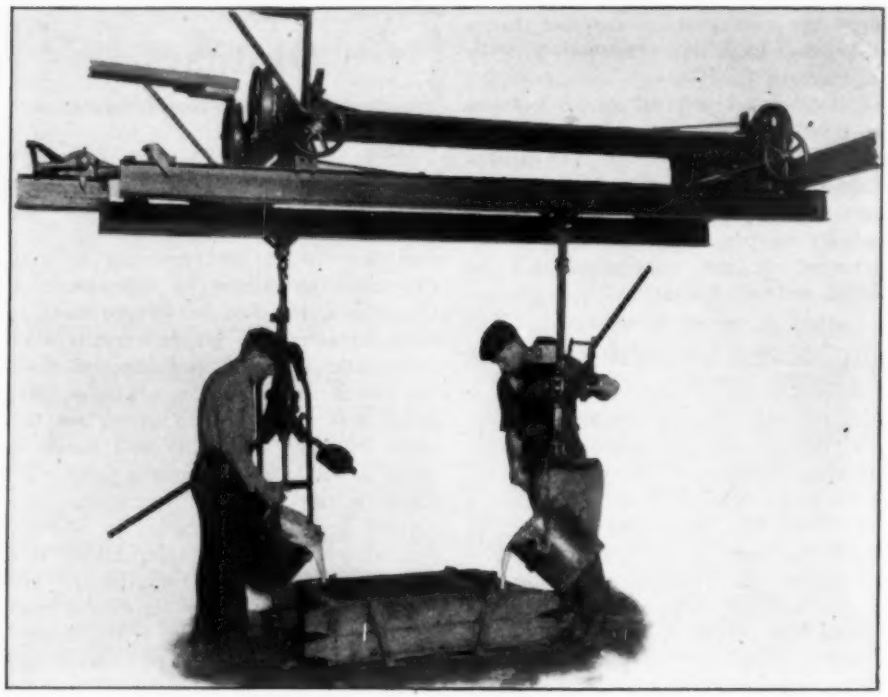
in between the caster top plate and bolster.

The framing consists of four longitudinal channels tied by channel ends which are joined to the side channels through malleable corner gussets to provide a rigid connection. Additional frame rigidity is provided by the type of wheel brackets, the cast steel truck bolster and their manner of attachment. A platform 36 x 72 inches is the standard size although any special size can be used and may be made of either wood or steel. Provision is made for end stakes, the stake pockets being tapered to hold the stake without rattling. A special coupler is used which provides a stationary pin at the caster end of the trailer and a horizontally pivoted bracket to engage a pin at the wheel end. Both coupler units are attached to the center sills of the frame by cast steel brackets.

Device Introduces Flux into Molten Metal

E. J. Woodison Co., Detroit, recently has placed on the market a device shown in the accompanying illustration. This equipment was designed by Richard Agricola to introduce a fluxing agent into a quantity of nonferrous crucible melted metal. It works on the principle that the fluxing agent must come into intimate contact with every portion of the metal in the crucible to accomplish the result for which it was intended. Briefly it may be described as a species of spray gun which shoots the flux into and distributes it throughout the body of metal in the crucible.

RENOVATOR INTRODUCES FLUX BY COMPRESSED AIR



ONE OF THE UNDERHUNG BEAMS IS MOVEABLE AND CAN BE ADJUSTED TO SUIT VARIOUS SIZED FLASKS FROM 18-INCH SPRUE CENTERS UPWARD

Pours Several Ladles of Metal at One Time

The double I-beam underhung, adjustable crane shown in the accompanying illustration has been placed on the market by the Modern Pouring Device Co., Port Washington, Wis., for pouring molds two, three or four-up. Two I-beams, one stationary and the other movable suspended from an ordinary crane renders it feasible to run two or more pouring machines on each I-beam sufficiently far apart to pour various sprues conveniently. The moveable I-beam may be adjusted on an underhung runway by means of two screws fastened to the ends of the stationary beam. The crane can be used over any size molds from 18-inch sprue centers upward.

Where the metal is brought directly from the furnace in a ladle held in the pouring device each of the underslung I-beams in turn is brought in line with the monorail junction and securely locked by a patented locking device. After the required number of ladles are suspended from the crane the locking device is disengaged and the crane moved over the molds. When pouring the molds the pouring devices are operated independently of each other. Where the metal is distributed to the floors in bull ladles, the machines hang suspended from the ends of the I-beams and the ladles are filled in the usual manner. It is stated that every precaution has been taken to make this crane safe in operation. All parts except the roller bearing housings and crane wheels are made either of structural or cast steel. When the trolley passes from the monorail beam to the underhung I-beam, the I-beams are locked firmly together. When the lock is opened two steel lugs drop down automatically and prevent the trolley from running off the end of the I-beam. All the wheels are equipped with Hyatt roller bearings.

When not in use pouring iron it is claimed it can be used as an ordinary foundry crane. A load may be suspended from one, two or all three I-beams. Application has been made for a patent on this construction.

Solder For Aluminum

A solder extensively used for aluminum is composed of tin, 63 per cent; zinc, 31 per cent; aluminum, 3 per cent, and phosphor tin, 3 per cent. The phosphor tin should contain 5 per cent phosphorus.

The art of flask casting in sand molds was patented in 1708 by Abraham Darby, then in charge of a brass foundry in Bristol, England. For more than a hundred years this process was carried on in secret.

Quiet Rules in Equipment Market

Heavy Foundry Machinery Demand Continues Light Due to Scarcity of Extensions in Shop Facilities—Inquiry Considered More Encouraging and Light Sundries Gain

WITH a few notable exceptions the demand for foundry equipment again is exceedingly quiet. Inquiries for heavy foundry machinery which have been pending for several weeks remain unclosed. Ladles, flasks and light sundries are slightly more active, and repair orders continue in sufficient volume to indicate some betterment in general foundry operations. New inquiry for molding machines, sand mixing machinery and cleaning room equipment is slightly better during the past few weeks.

Pittsburgh District Buying Light Sundries

WITH the exception of the radiator and sanitary casting plants, foundry operations average about 20 per cent of normal and equipment sales are correspondingly slow in the Pittsburgh area. Several sizeable orders await improved conditions in foundry lines, but at the present time, buying is confined to ladles, flasks and smaller sundries. However, inquiries are extant for molding machines, a large cupola and some large core oven equipment for delivery within the district. Repair inquiries continue and refractories and cupola lining materials are in slightly better demand. The Pittsburgh Metallurgical Corp. has purchased a five ton crane from the Northern Engineering Works, Detroit. Prospective equipment purchasers include the newly incorporated Pittsburgh Engineering Foundry & Construction Co. and the Pittsburgh Malleable Iron Co. The latter is constructing an addition. F. J. Ryan & Co., Philadelphia, recently have accepted contracts to install furnaces for the Electric Manganese Steel Co., the United States Cast Iron Pipe & Foundry Co., and the Crucible Steel Castings Co., the Armstrong Cork Co. and the George W. Tyrell Co.

Eastern Market Gains Strength

KEEN competition, in conjunction with slightly greater activity at various foundries, is resulting in an improvement in demand for foundry equipment. While equipment sellers pronounce the situation far from active, they assert that small orders are coming out in better volume. One seller reports a substantial improvement in the buying of molding machines and flasks. While some of this business is for replacement purposes, he expressed the opinion that in a number of cases equipment is being purchased for the first time, due to necessity occasioned by the sharp competition now existing. Few new foundry projects are noted, although expansion is being made at some plants in this district. The Plainville Casting Co., Plainville, Conn., is erecting an addition and is buying some miscellaneous equipment at this time. The American Locomotive Co. is expanding its plant at Schenectady, N. Y., and has recently purchased a complete set of geared ladles and some conveying equipment. Some other purchases are yet to be made. The H. B. Smith Machine Co., Smithville, N. J., is enlarging its foundry and its buying equipment. The Standard Sanitation Co., New Brighton Pa., and the E. P. Bailey Co., Nitro, W. Va., are said to be prospective buyers of foundry equipment. The government has announced that it has abandoned the project of establishing a vocational school at Camp Dix, Ricetown, N. J. A foundry was to have been included and bids had been asked on about $5000 worth of equipment. The board of education, New York City, is expected to be in the market within the next month or so, for a small list of foundry machines and supplies. The vehicular tunnel project between Manhattan and New Jersey, to which sellers are directing considerable attention, has not as yet become active; in fact, it appears now that contracts for the manufacture of the heavy tonnage of castings involved will not be awarded much before the first of the year. Export buying appears to be confined to the purchase of an occasional machine by the Chinese railroads and the Japanese government. Of late, $7000 or $8000 worth of equipment has been sold to these interests by a New York dealer. The American Car & Foundry Co., 30 Church street, New York City, which recently closed on two 5-ton electric cranes for Terre Haute, Ind., is in the market for two 5-ton electric cranes, with 75 and 90-foot spans, respectively, for St. Louis. It is understood, however, that only four builders will be asked to bid. The Maco Products Co., 149 Nassau street, New York City, contemplates the erection of a foundry in northern New Jersey. The J. W. Paxson Co., Philadelphia, foundry equipment, is building two plant structures.

Light Equipment Gains in Chicago District

FOR the first time in several months some concerns supplying foundry equipment and supplies find business is improving and the total for October was considerably better than that of September. Demand for ladles, trucks, cranes and similar equipment is much better and sales are much more frequent than during the summer. The Whiting Corp., Harvey, Ill., sold seven cupolas during October, which is a considerably better record than for some time. Inquiry for molding machines is much larger than in the past, but actual business booked during the past two weeks has been less in proportion than the inquiry would promise. However, much of this prospective business is alive and probably will result in orders shortly. The inquiry is for electric jolts, stripping plate machines and squeezers, one inquiry calling for four of the latter. The National Engineering Co. has sold three Simpson mixers recently, one going to Pennsylvania, one to Chicago and the third to an Illinois foundry. The condition as to building new foundries is not uniform as some prospective plans are being held back while others have been set forward and will be built sooner than had been planned. One engineering firm is now making plans for several new foundries projected for construction during 1923, but plans are being completed so that they can be taken up earlier if business conditions warrant. A new malleable foundry is to be built this winter at Cadillac, Mich., by a company organized by R. J. Teetor of Muskegon and associates and it is planned to have it in operation about July 1, 1922. The product will be malleable castings from charcoal iron.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

Installation of an electric furnace is being completed by the Williamson-Harris Machine Co. as a new addition to the company's foundry at Cordele, Ga. The company will start the manufacture of steel castings as soon as the furnace has been completed. The firm manufactures stump pullers and wheel presses.

Work has been started on tearing down the old buildings at the American Car & Foundry Co., Terre Haute, Ind., which were partially destroyed by fire some time ago. When the old buildings have been wrecked work will immediately begin on the construction of new structures, according to an announcement by E. D. Buick, district manager. The shops are to be entirely new and modern. No attempt will be made to open the car shops until the new buildings have been completed.

The McWane Pipe Co. with J. R. McWane as president, and J. D. Sample as vice president and treasurer, has been organized at Birmingham, Ala., for the purpose of manufacturing a patented joint for high pressure pipe, and also to manufacture 2 and 3-inch pipe. The new company has leased a plant in north Birmingham which will be the nucleus for the new industry. Mr. McWane who is president of the American Cast Iron Pipe Co. will continue in that capacity until Jan. 1. He will remain as a stockholder and director of the American company.

Capitalized at $25,000, the Duke Boltless Rail Joint Co. has been organized and incorporated at La Grange, Ga., by G. W. Duke, J. T. Thomasson and J. C. Thomas. The company proposes to establish a foundry and machine shop for the manufacture of its product as well as other castings and iron and steel products.

It is reported that the Bowie Stove Foundry Co., Rome, Ga., is considering rebuilding its plant which was recently damaged by fire.

The Kelly & Jones Co., Pittsburgh, manufacturer of pipe fittings, valves, etc., recently purchased a plant at Chicago.

The Cumberland Foundry & Supply Co., Cumberland, Md., has leased the foundry of the Union Mining Co. near Frostburg, Md., which it will utilize. Frank Snyder is manager of the company.

Construction is progressing rapidly on the erection of an addition to the plant of the S. C. McLouth Foundry Co., Marine City, Mich.

To manufacture copper, brass and other metal products, the Hendricks Brass & Copper Co., 130 Market street, Newark, N. J., recently was incorporated by Elwood Hendricks, 645 Springdale avenue, East Orange, N. J., and others.

The capitalization of the Bellaire Stove Co., Bellaire, O., recently was increased from $50,000 to $100,000.

Plans are said to be under contemplation by Dunlap & Jones, Pottsville, Pa., for the rebuilding of their foundry, which was recently badly damaged by fire.

Capitalized at $25,000, the El Reno Foundry & Machine Co., El Reno, Okla., recently was incorporated to engage in a general foundry business, by Frank Kraft, H. T. Smith and E. H. Breur.

The Alliance Brass Co., Ltd., Peterborough, Ont., recently was incorporated to manufacture various metal products, with a capital stock of $75,000, by George N. Gordon, Joseph A. O'Brien, and others.

The new $300,000 foundry of the Gilbert & Barker Mfg. Co., West Springfield, Mass., said to be the largest and best equipped in New England, recently was opened for inspection. To Robert H. McNall and Charles C. Ramsdell, president and vice president, respectively of the company, went the honor of pouring the first metal. Among the guests were T. J. Williams of the Standard Oil Co. of New Jersey, a director of the Gilbert & Barker Mfg. Co. The new foundry is 400 feet long and 80 feet wide, and has a capacity of producing 100 tons of metal daily. It was erected so that the company may make its own castings.

Completion and operation of a new plant at Brantford, Ont., is announced by the Brant Foundries, Ltd. The Brant Foundries were established to take care of the casting needs of plants in the Brantford district and will make a specialty of light gray-iron, brass and aluminum castings. The plant is modern in every respect.

Bids have been received by the Crane Co., Bridgeport, Conn., for the erection of an addition to its furnace building.

Work has been started by the Plainville Casting Co., Plainville, Conn., on the erection of a foundry building, 60 x 145 feet, which will be built adjoining its present foundry.

The plant of the P. H. Magarl Foundry & Furnace Works, East Oakland avenue, Bloomington, Ill., recently was damaged by fire. Plans of the company have not been announced.

Contracts have been let by the Peterson & Reedy Pattern Works, 4650 Iowa street, Chicago, for the erection of a 1-story pattern shop, 24 x 100 feet.

A stove plant, consisting of three structures, 70 x 300 feet, 70 x 100 feet and 24 x 70 feet, will be built by the Cabaret Range Co., Granite City, Ill.

The plant of the Thomas Laughlin Co., Portland, Me., manufacturer of marine hardware, recently was damaged by fire. The loss was estimated at $30,000.

The plant of the Electro Refractories Co., East Hamburg, N. Y., recently was damaged by fire. Rebuilding plans of the company have not been announced.

To manufacture and deal in castings, etc., the Cal-Met Mfg. Co., Oakland, Cal., recently was incorporated with a capital stock of $1,500,000, by Anton Webb, Forty-seventh and East Twelfth streets, Oakland, and others.

Work has been started by the Muskogee Tool Co., Henryetta, Okla., for the erection of a plant which will include a modern foundry building.

Erection of a foundry building and the installation of new modern machinery is planned by the American Foundry Co., Salisbury, N. C. Thomas G. Shelton is superintendent of the company.

The foundry owned by Cie de Pulpe de Chicoutimi, Chicoutimi, Que., recently was damaged by fire, the loss being estimated at $50,000. It is reported the company plans to rebuild immediately.

The Automatic Water-Oil Burner Co., Ltd., Montreal, Que., recently was incorporated with a capital stock of $50,000 to engage in the manufacture of furnaces, stoves, etc., by Alexander Papineau, Armand Mathiew and P. F. Richardson.

The Standard Sanitary Mfg. Co., Louisville, Ky., plans to build an addition to its plant to increase its capacity to 500 bath tubs a day. It is estimated the addition will cost approximately $200,000.

The Maco Products Co., 149 Nassau street, New York, is reported contemplating the erection of a foundry building in northern New Jersey.

Two plant buildings are under construction for the J. W. Paxson Co., Philadelphia, manufacturer of foundry equipment.

The American Locomotive Co. is erecting additions to its plant at Schenectady, N. Y., and recently bought a quantity of foundry equipment.

Work has been started by the H. B. Smith Machine Co., Smithville, N. J., on enlargement of its foundry. The company is buying some equipment.

The Atlas Powder Co., Marshall, Tex., plans to erect a plant consisting of a furnace building, machine shop, engine house, power plant, carpenter shop and other structures.

New Trade Publications

STARTING SWITCH—Allen-Bradley Co., Milwaukee, is circulating an 8-page illustrated booklet in which an automatic starting switch for small induction motors is described and illustrated. This starter is of the cross-the-line type. A complete description is given in the booklet.

TUBE WELDING MACHINERY — The Davis-Bournonville Co., Jersey City, N. J., has published a 24-page illustrated booklet in which tube welding machinery and fabricating machinery is described and illustrated. The machines described include slitters, forming machines, welding machines, straighteners, seam grinders, swagers, cutting-off machines, benders and drawbenches. Each machine is described in detail.

POWDERED FUEL BURNER—The K-B Pulverizer Co., Inc., New York, has published a 4-page folder in which a mechanical unit of an applicable system of burning powdered fuel is described and illustrated. The burner consists of a pulverizing machine and air separating chamber automatically fed from an overhead storage bin and delivering the powdered fuel by fan blast through piping to the combustion chamber. The machine is described in detail as to advantages and details of construction.

ENGINE—John Howden & Co. of America, Wellsville, N. Y., is circulating a 6-page illustrated folder in which a high-speed engine for direct coupling to dynamos for ship lighting is described and illustrated. These engines are made in all sizes up to 2500 horsepower. The engine is described in detail, the description being illustrated with line drawings and halftone illustrations.